HOLMES HALL, 1904.

TWENTIETH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE.

1904.

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The Bulletins of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,

Orono, Maine.

STATE OF MAINE.

Geo. E. Fellows, Ph. D., President of the University of Maine:

SIR:—I transmit herewith the Twentieth Annual Report of the Maine Agricultural Experiment Station for the year ending December 31, 1904.

CHARLES D. WOODS,

Director.

ORONO, ME., December 31, 1904.

MAINE

AGRICULTURAL EXPERIMENT STATION,

ORONO, MAINE.

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ANNOUNCEMENTS.

THE AIM OF THE STATION.

Every citizen of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glass-ware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published, if they prove of general interest.

INSPECTIONS.

The execution of the laws regulating the sale of commercial fertilizers, concentrated commercial feeding stuffs, and agricultural seeds, and the inspection of chemical glassware used by creameries is entrusted to the Director of the Station. The Station officers take pains to obtain for analysis samples of all brands of fertilizers and feeding stuffs coming under the law, but the organized co-operation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and other organizations can render efficient aid by reporting any attempt at evasion of the laws and by sending, early in the sea-

son, samples taken from stock in the market and drawn in accordance with the Station directions for sampling. In case there should be a number of samples of the same brand sent in, the Station reserves the right to analyze only in part.

STATION PUBLICATIONS.

The Station publishes several bulletins each year, covering in detail its expenses, operations, investigations and results. The bulletins are mailed free to all citizens who request them.

CORRESPONDENCE.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications should, therefore, be addressed to the

Agricultural Experiment Station,
Orono, Maine.

The post office, railroad station, freight, express and telegraph address is Orono, Maine. Visitors to the Station can take the electric cars at Bangor and Old Town.

The telephone call is "Orono 5."

Directions, forms and labels for taking samples of fertilizers, feeding stuffs and seeds for analysis can be had on application.

Parcels sent by express should be prepaid, and postage should be enclosed in private letters demanding a reply.

CHAS. D. WOODS, *Director.*

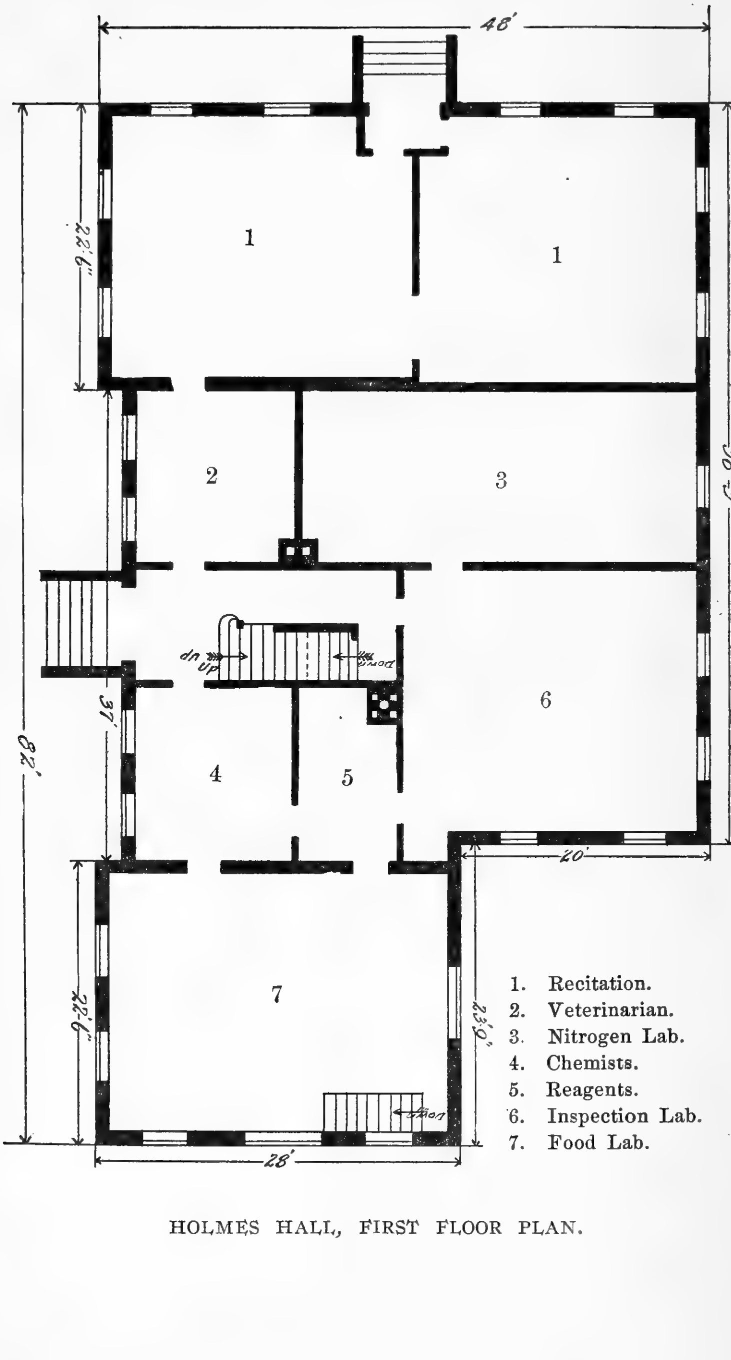
HOLMES HALL, 1888.

HOLMES HALL, 1899.

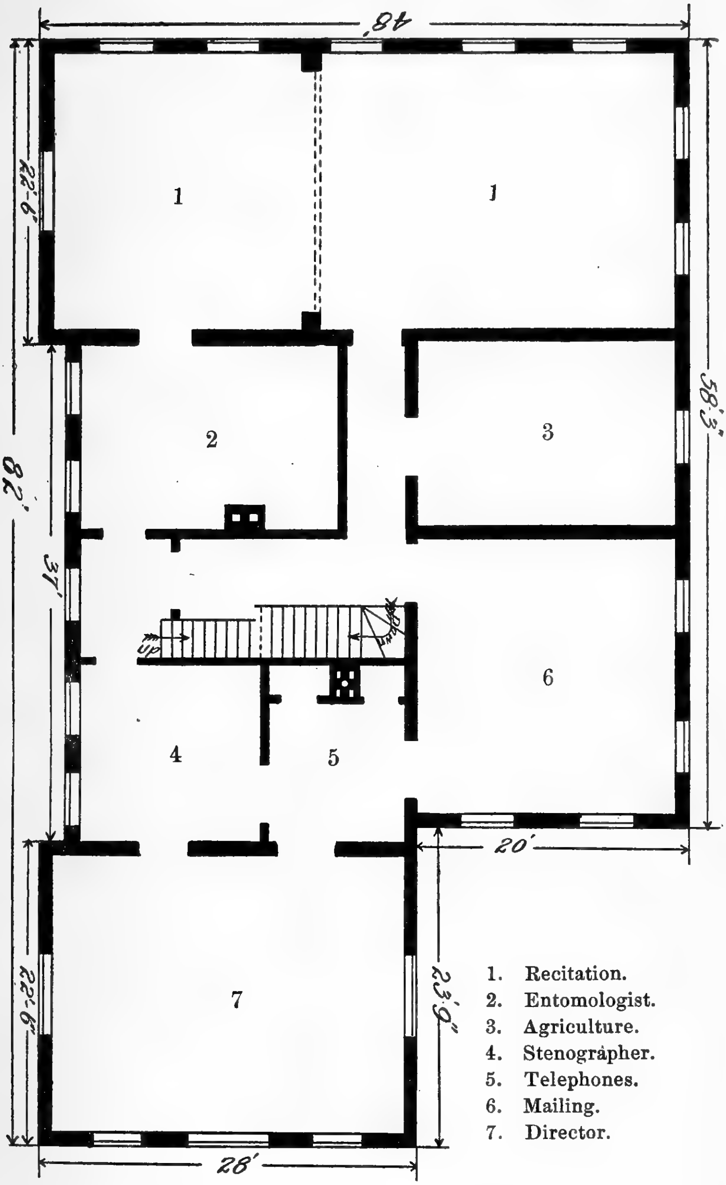
HISTORICAL SKETCH.

The Maine Fertilizer Control and Agricultural Experiment Station was established by the Maine legislature of 1885, which appropriated the sum of $5,000 a year for its maintenance. No provision, however, was made for a building for its accommodation, so the trustees of the State College offered it quarters, although it was established as an independent institution, and the Board of Managers gladly accepted the offer. A laboratory was provided in Fernald Hall and an office in Wingate Hall—the wooden building, since burned, which stood where the present Wingate Hall is located. This State Station was maintained until the passage by Congress of the Hatch Bill in 1887 placed at the disposal of the University the sum of $15,000 annually for the maintenance of an Agricultural Experiment Station, after which it was discontinued.

The increase in the funds available for the support of a station permitted a considerable increase in the staff of investigation, and a consequent increase in its work, which made increased laboratory and office facilities imperative. To meet this demand, it was decided to erect a new building for the exclusive use of the Station, to be located upon the slight elevation to the east of Coburn Hall, one of the very best sites upon the campus. This building was constructed in 1887. It was built of brick with granite trimmings, and was two stories in height, with a one-story ell. In 1899 the building was enlarged by adding a wing to the south side, thus providing much needed space for food laboratories and the director's office. In the latter is placed the greater part of the station library of about 1,700 volumes. The appearance of the building in these two stages of its development is shown in the two illustrations.



HOLMES HALL, FIRST FLOOR PLAN.



HOLMES HALL, SECOND FLOOR PLAN.

In 1903-04, in accordance with a previous plan, a second wing was added on the north side, thus restoring the symmetry of the building. The structure thus completed is in the form of a rectangle 46 by 82 feet, with a re-entrant angle at the southeast corner. On the first floor (see plan, p. x) are the laboratory for the analysis of feeds and fertilizers, the nitrogen room, a room for the storage of chemicals, a food laboratory, offices of the chemists and veterinarian, and in the recently completed north wing, recitation rooms for the departments of horticulture and forestry. On the second floor (see plan, p. xi) are the director's office, rooms for the professor of agriculture, the entomologist, the stenographer, a mailing and reading room, a telephone room, and in the north wing a large room used for recitation and laboratory purposes by the department of agriculture. This room may be divided into two rooms or thrown into one by a rolling shutter.

The basement contains the boiler and coal rooms, a kitchen used in connection with nutrition investigations, a calorimeter room, a gas room, and rooms for the grinding and preparation of samples. In the attic are quarters for the janitor, a photographic dark room, and a storage room. The building is heated by steam, lighted by electricity, and furnished with gas. The total cost is somewhat in excess of $18,000. The completed building is shown in the full page illustration.

The recent additions give a dignified building, designed and erected for agricultural investigation and instruction, and it seemed to the trustees of the University to be eminently fitting that it should bear the name of one of our most eminent pioneers in agricultural science, Ezekiel Holmes. This honor is the more deserved, since Dr. Holmes, over 60 years ago, urged the establishment in Aroostook county of a "State Experiment Farm;" and it was largely through his efforts that the Maine legislature in 1865 established the Maine State College as a separate and independent institution. Holmes Hall was formally dedicated on May 25, 1904.

Warmed House. Curtain Front House.

Fig. 1. POULTRY HOUSES DESCRIBED ON PAGES 11-16.

POULTRY MANAGEMENT AT THE MAINE AGRICULTURAL EXPERIMENT STATION.

G. M. Gowell.

Many years practical experience in raising and keeping poultry and investigations in poultry breeding at this Station have resulted in the accumulation of a considerable fund of information on poultry management. The object of this paper is to outline this experience for the benefit of poultry keepers, and help them discriminate between some of the wrong theories which have underlain much of the common practice of the past, and the better theories, which underlie other and newer methods that are yielding more satisfactory results. It may be that the methods in vogue with us are no better than those practiced by others, but in the following pages the attempt is made to concisely state the practices which are now being successfully employed at this Station.

The difficulties attending artificial poultry keeping lie in the numbers of small animals that make up the business. With most domestic animals the care-taker treats each one individually, and there is far less draft on the abilities of the herdsman with his large animals than on the manager of even a small poultry plant with its far greater numbers of individuals.

Labor is the costliest factor that enters into the management and equipment of a poultry farm. The cost of food required to produce a pound of beef, pork or chicken does not differ greatly, but while the dressed steer and pig sell for from 5 to 8 cents per pound, the chicken sells for from 15 to 20 cents per pound, and early in the season for much more. The differences in their selling prices represent the differences in the risk and the skill employed in their production. Furthermore, the increasing demand for choice articles of food will tend to maintain these prices, even though the supply be greatly increased. The products of the poultry farms, the fresh self-sealed eggs, each an

unbroken package in itself, and the delicately flavored chickens, are among the choicest articles of food to be found in the markets.

While poultry raising is exacting in its demands, there are no conditions imposed that cannot be compassed by persons of ordinary mental and physical capacity. In this as in other callings, the skill which comes from thorough training and the energy needed for persistent work are essential to the fullest success.

The history of the poultry industry of this country is being rapidly made, these years, on the farms, village lots, and at the experiment stations, and written in the minds of the thousands of earnest workers who are engaged in it. From this accumulated knowledge is to come, in the near future, a better, general understanding of the subject, which will enable men or women of ordinary abilities to take up the work for themselves, in a small way, and proceed without making many of the mistakes that caused their predecessors to waste money and labor, and lose heart. Poultry and egg production are as legitimate lines of work for persons of small or large means as are dairying, beef growing, sheep husbandry, or general or special crop production. Its advantages lie in its greater returns for its smaller capital investment. Its disadvantages lie in the demand for greater skill, patience and courage than will suffice for any other special, or general farm industry.

RAISING CHICKENS BY NATURAL PROCESSES.

Circumstances sometimes make it necessary to hatch and raise chickens by aid of the mother hen. While we do not like the method, we have practiced it; having at times as many as a hundred sitting hens along the side of a room—in two tiers—one above the other. An unused tieup in a barn was taken for the incubating room and a platform was made along the side next to the barn floor. The platform was 3 feet above the floor and was two and a half feet wide and 50 feet long. It was divided up into 50 little stalls or nests, each one foot wide and 2 feet long, and one foot high. This left a 6 inch walk along in front of the nests, for the hens to light on when flying up from the floor. Each nest had a door made of laths at the front, so as to

give ventilation. It was hinged at the bottom and turned outward. Across the center of each nest, a low partition was placed, so that the nesting material would be kept in the back end, the nest proper. For early spring work paper was put in the bottom of the nest, then an inch or two of dry earth, and on that the nest, made of soft hay.

Whenever half a dozen hens became broody they were taken in from the hen house and put on the nests, each nest having a dummy egg in it; the covers were then shut up and nearly every hen seemed contented. In a day or two thirteen eggs were placed under each bird. Every morning the hens were liberated as soon as it was light, when they would come down of their own accord and burrow in the dry dust on the floor, eat, drink, and exercise, and in twelve or fifteen minutes, they would nearly all go onto the nests voluntarily. In the afternoons one would occasionally be found off the eggs, looking out through the slatted door. If she persisted in coming off she was exchanged for a better sitter. The double nest is necessary, otherwise the discontented hen would have no room to stand up, except on her nest full of eggs, and she would very likely ruin them. With the double nest there was no danger of this, as she would step off the nest, go to the door, and try to get out. The arrangement was satisfactory and were it not for the lice, which were not easily gotten rid of, since the chicks grew with the mother hen, we would prefer it to some incubators we have used.

The advantages of a closed room in which to confine the sitters are many, as the hens are easily controlled and do not need watching as they do when selecting nests for themselves, or when sitting in the same room with laying hens. A room a dozen feet square could be arranged so as to easily accommodate fifty sitters. Except for the small operator we would not encourage the use of sitting hens.

For the accommodation of the hen with her brood of young chicks, the best arrangement consists of a close coop about 30 inches square, with a hinged roof, and a movable floor in two parts, which can be lifted out each day for cleaning. This little coop has a wire covered yard attached to it on the south side. The yard is 4 by 5 feet in size and a foot and a half high. Its frame is of 1x3 inch strips and is fastened securely to the coop.

The wire on the sides is of one inch mesh, but on top two inch mesh is sufficient. The coop is easily kept clean and the coop and yard can be set over onto clean grass by one person.

The small run is sufficient for the first few weeks, but soon the chicks need a greater range and then the farther end of the run can be lifted up 3 or 4 inches and they can pass in and out at will, while the mother will be secure at home, and they will know where to find her when they get cold or damp, and need brooding. Such a coop accommodates 15 to 20 chicks until they no longer require brooding, after which several flocks are combined in one and put in a portable house on a grassy range.

Whenever the hen is allowed to hatch, or to mother chicks, much care must be experienced or lice will get a foothold and ruin the birds. The free and frequent use of fresh insect powder upon the hen, working it through the feathers to the skin, is one of the best methods for destroying the pests. Grease or oil are effective when applied to the heads and under the wings of young chicks, but care must be taken not to get too much on them, especially during damp weather. The feeding of chicks raised in coops with their mothers does not vary much from those raised in brooders.

RAISING CHICKENS BY ARTIFICIAL PROCESSES.

Incubators have been so much improved that there are several kinds on the market that we feel sure will hatch as many chicks from a given lot of eggs as can be done by selected broody hens. They require little care, maintain an even temperature, and are easily adjusted to meet the increase in temperature arising from developments going on in the eggs. In some machines the moisture supply is automatic and adapted to the requirements. In others it has to be supplied, and skill is necessary in determining the quantity needed. The economy of the incubator is very great. A 360 egg machine will do the work of nearly 30 broody hens, and can be kept at work continually, if desired. We commenced our work in artificial incubation years ago, by trying to maintain the temperature in a home-made wooden box, with double walls, by the use of jugs of warm water. By locating the box in a suitable room and keeping close watch on conditions, good

Fig. 2. BROODER HOUSES ON THE RANGE.
See page 6.

hatches were obtained. It was the best there was at that time, but the use of home-made incubators now, would be like turning back into the days of the wooden plow.

There are several kinds of good incubators, but the one which we have used with greatest satisfaction is the Cyphers, with its capacity of 360 eggs. We have used others that hatch as well, but the Cyphers requires less care. We have not tested many incubators and other makes that we have not used may be as good.

The incubator room must be kept quite constant in temperature. A cellar is a good place in which to run incubators if it is not so cold as to require the lamps to be run very high in order to maintain the necessary degree of warmth inside of the machine. If several incubators are located in the same room, great care should be taken to provide proper ventilation, so that the machines may be furnished with clean fresh air at all times.

Where many machines are used, the hand turning of the eggs absorbs considerable time. We have used several turning devices and conducted experiments to determine the differences between hand and machine turning, and have not yet received better hatches from the hand turned eggs. Machines that have automatic turning shelves will not hold quite as many eggs as when flat shelves are used, but the saving of time is of importance.

A person should get thoroughly acquainted with a machine before putting the eggs in and then make changes and adjustments with great care, lest the results be extreme. We used to think it necessary to have the chickens hatched in March so that they might be ready for laying by November. By better methods of feeding and treatment we can now delay the hatching until April, and the first half of May, and the pullets get to laying maturity as early in the season as formerly.

We use indoor brooders, mostly, and very much prefer them to any outside brooders we have seen in use. The portable brooder houses are built on runners so that they may be readily moved about. The houses are 12 feet long, some of them are 6 and others 7 feet wide. Seven feet is the better width. They are 6 feet high in front and 4 feet high at the back. The frame is of 2x3 inch stuff; the floor is double boarded. The building is

boarded, papered and shingled all over. A door, 2 feet wide is in the center of the front and a 6 light, sliding window is on each side of it. A small slide is put in the door, near the top, by which ventilation may be obtained early in the season, before the windows can be kept open. Since shingles on the walls near the bottom are liable to be torn off in moving the houses, double boarding on the walls would be preferable. Two brooders are placed in each of these houses and 50 to 60 chicks are put with each brooder. A low partition separates the flocks while they are young, but later it has to be made higher. The houses are large enough so that a person can go in and do the work comfortably and each one accommodates 100 chicks until the cockerels are large enough to be removed.

In the fall these houses are grouped together, 20 or 30 feet from each other, so as to make the care of the young chicks convenient in early spring while the brooders are in use.

About the 20th of June the grass is cut on some field near to the main poultry, or farm buildings, and the brooder houses are drawn out, with their contents of chickens, and located 50 to 75 feet from each other, in lines, so that they may be reached with little travel. The chickens are shut into small yards, adjoining the houses, for about a week, after which they are allowed to run together. They mostly keep to their own houses, although they wander away quite long distances during the day, returning at feed time, and at night.

The most satisfactory brooder that we have used is the "Peep O' Day." The style that we like best has the cover and part of one side arranged to turn down, making an inclining run the whole width of the brooder, up and down which the little chicks can go without crowding. Some of the later styles of brooders made by this company are not as satisfactory, as they have little passages, through which the chicks are to pass up and down, and they require more or less teaching before they will use them.

Most kinds of brooders as now made, keep the chicks comfortable, at desired temperatures, and have good means of ventilation. The great difficulty lies in the lamps used. The lamp apartments are small and the tendency is for the oil to become warm and form gases, which causes the flame to stream up and make trouble. Most brooder lamps have water pans between the oil tank and the burner which tend to keep the oil cool, but

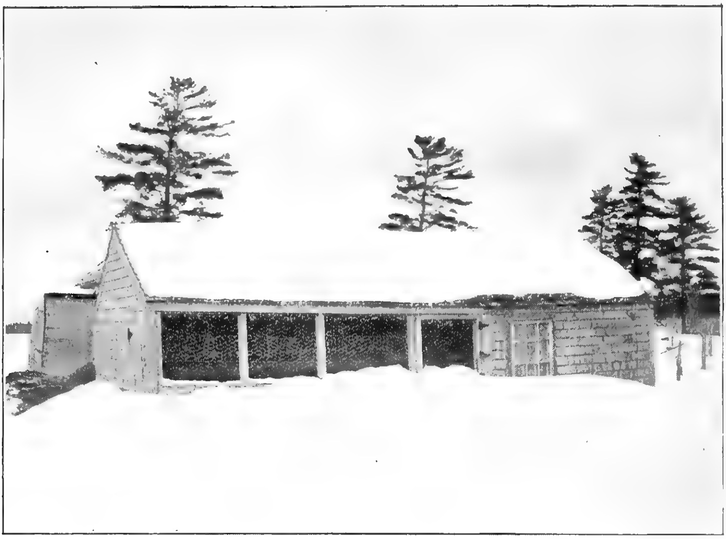


Fig. 3. PIONEER OPEN FRONT HOUSE.
Described on page 12.

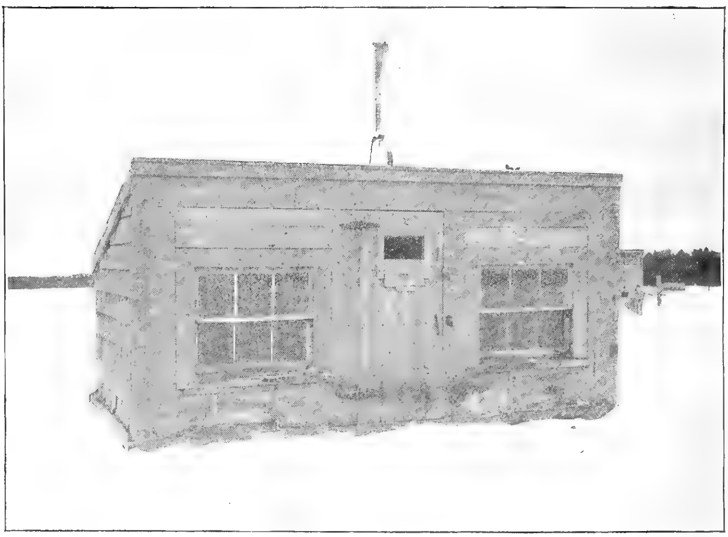


Fig. 4. BROODER HOUSE.
Described on page 5.

even with this precaution we have had two fires, one of which was very serious. The old Peep O' Day lamp was of this kind, but the new ones are entirely different and by far the best of any we have seen. They have no water pans, but are so arranged that currents of cool air pass constantly over the oil tank and keep its contents cool. We have used these lamps, or stoves, for three years—last year more than twenty of them—and regard them as safe, for the oil has never become warm.

TREATMENT OF YOUNG CHICKS.

When the chicks are 30 to 40 hours old they are carried in warm covered baskets to the brooders, and 50 or 60 are put under each hover, where the temperature is between 95 and 100 degrees. The temperature is not allowed to fall below 95 degrees the first week, or 90 during the second week; then it is gradually reduced according to the temperature outside, care being taken not to drive the chicks out by too much heat, or to cause them to crowd together under the hover because they are cold. They should flatten out separately, when young, and a little later, lie with their heads just at the edge of the fringe of the hover. Under no condition are they allowed to huddle outside of the brooder. They huddle because they are cold, and they should be put under the hover to get warm, until they learn to do so of their own accord. Neither are they allowed to stay under the hover too much, but are forced out into the cooler air where they gain strength in the day time. They are not allowed to get more than a foot from the hover during the first two days; then a little further away each day, and down onto the house floor about the fourth or fifth day, if the weather is not too cold. They must not get cold enough to huddle or cry, but they *must* come out from under the hover frequently.

The floor of the brooder is cleaned every day and kept well sprinkled with sharp, fine crushed rock, known in the market as "chicken grit." The floor of the house is covered with clover leaves, or hay chaff, from the feeding floor in the cattle barns. For raising winter chickens the long piped brooder house is indispensable, and it has many advantages when used at any season of the year. The advantages are especially great when raising chickens, if April or May prove to be cold and wet, for then the small houses are apt to be cold outside of the brooders.

The expenditure is greater for the piped house, for the reason that colony houses should be provided in which the chickens may be sheltered after they leave the brooder-house. In ordinary seasons we experience no difficulty in raising April and May hatched chicks in the small houses. With proper feeding, pullets hatched in these months are early enough to do good work throughout the year.

FEEDING THE CHICKS.

For feed for young chicks we make bread by mixing three parts corn meal, one part wheat bran, and one part wheat middlings or flour, with skim milk or water, mixing it very dry, and salting as usual for bread. It is baked thoroughly, and when well done if it is not dry enough so as to crumble, it is broken up and dried out in the oven and then ground in a mortar or mill. The infertile eggs are hard boiled and ground shell and all, in a sausage mill. About one part of ground egg and four parts of the bread crumbs are rubbed together until the egg is well divided. This bread makes up about one-half of the food of the chicks until they are five or six weeks old. Eggs are always used with it for the first one or two weeks, and then fine sifted beef scrap is mixed with the bread.

It may be that the bread is not necessary and that something else is just as good. We have tried many other foods, including several of the most highly advertised prepared dry chicken foods, but as yet have found nothing that gives us as good health and growth as the bread fed in connection with dry broken grains.

When the chicks are first brought to the brooders, bread crumbs are sprinkled on the floor of the brooder among the grit, and in this way they learn to eat, taking in grit and food at the same time. After the first day the food is given in tin plates, 4 to each brooder. The plates have low edges, and the chicks go onto them and find the food readily. After they have had the food before them for five minutes the plates are removed. As they have not spilled much of it, they have little left to lunch on except what they scratch for. In the course of a few days light wooden troughs are substituted for the plates. The bottom of the trough is a strip of half inch board, 2 feet long and 3 inches wide. Laths are nailed around the edges. The birds are

fed four times a day in these troughs until they outgrow them, as follows: Bread and egg or scrap early in the morning; at half past nine o'clock dry grain, either pin head oats, crushed wheat, millett seed or cracked corn. At one o'clock dry grain again, and the last feed of the day is of the bread with egg or scrap.

Between the four feeds in the pans or troughs, millett seed, pin head oats and fine cracked corn, and later whole wheat, are scattered in the chaff on the floor for the chicks to scratch for. This makes them exercise, and care is taken that they do not find the food too easily.

One condition is made imperative in our feeding. The food is never to remain in the troughs more than 5 minutes before the troughs are cleaned or removed. This insures sharp appetites at meal time, and guards against inactivity which comes from over feeding.

Charcoal, granulated bone, oyster shell and sharp grit are always kept by them, as well as clean water. Mangolds are cut into slices, which they soon learn to peck. When the grass begins to grow they are able to get green food from the yards. If the small yards are worn out before they are moved to the range, green cut clover or rape is fed to them.

After the chickens are moved to the range they are fed in the same manner, except that the morning and evening feed is made of corn meal, middlings and wheat bran, to which one tenth as much beef scrap is added. The other two feeds are of wheat and cracked corn. One year we fed double the amount of scrap all through the growing season and had the April and May pullets well developed and laying through September and October. To our sorrow they nearly all moulted in December, and that month and January were nearly bare of eggs.

FEEDING THE COCKERELS FOR MARKET.

When the chickens are moved to the field the sexes are separated. The pullets are cared for as explained above. The cockerels are confined in yards, in lots of about 100, and fed twice daily on porridge made of 4 parts corn meal, 2 parts middlings or flour, and one part fine beef scrap. The mixed meals are wet with skim milk or water—milk is preferred—until the mixture will just run, but not drop, from the end of a wooden

spoon. They are given what they will eat of this in the morning and again towards evening. It is left before them until all have eaten heartily, not more than an hour at one time, after which the troughs are removed and cleaned. The cockerels are given plenty of shade and kept as quiet as possible.

We have found our chickens that are about one hundred days old at the beginning to gain in four weeks' feeding, from one and three-fourths to two and one-fourth pounds each and sometimes more.* Confined and fed in this way they are meaty and soft and in very much better market condition than though they had been fed generously on dry grains and given more liberty. Poultry raisers cannot afford to sell the chickens as they run, but they can profit greatly by fleshing and fattening them as described. Many careful tests in chicken feeding have shown that as great gains are as cheaply and more easily made, when the chickens, in lots not to exceed 100, are put in a house with a floor space of 75 to 100 feet and a yard of corresponding size, as when they are divided into lots of 4 birds each and confined in latticed coops, just large enough to hold them. Four weeks has been about the limit of profitable feeding, both in the large and small lots. Chickens gain faster while young. In every case birds that were one hundred and fifty to one hundred and seventy-five days old have given us comparatively small gains. The practice of successful poultrymen in selling the cockerels at the earliest marketable age is well founded, for the spring chicken, sold at Thanksgiving time is an expensive product.

A very large proportion of the chickens raised in this State are sent to market alive, without being fattened, usually bringing to the growers from twenty-five to thirty-five cents each. The experiments referred to above indicate that they can be retained and fed a few weeks, in inexpensive sheds, or large coops with small runs, and sent to the markets dressed, and make good returns for the labor and care expended. The quality of the well-covered, soft fleshed chickens, if not too fat, is so much superior to the same birds not specially prepared, that they will be sought for at the higher price. The dairy farmer is particularly well prepared to carry on this work as he has the skim milk which is of great importance in obtaining yield and quality of flesh.

*See bulletins 64 and 79 of this station.

THE WARMED HOUSE FOR HENS.

This house, which was erected in 1898, is 16 feet wide and 150 feet long. It faces the south and conforms nearly to the land surface, the east end being 3½ feet lower than the west end. The sills are of 4x6 inch hemlock, placed flat, upon a rough stone wall which rests upon the ground surface, and varies from one to two feet in height. The earth is graded up to within six inches of the sills on the outside. The floor timbers are 2x8 inches, placed 2½ feet apart, and rest on the sills. The studs for the back wall are 2x4 stuff, 5 feet 8 inches long, and rest on the sills. The front studs are 10 feet 6 inches long. All the studs are set 3 feet apart. Each 10 feet in length of the front of the building has one 12 light window of 10x12 glass. The top of this window comes within one foot of the plate. Directly underneath these windows and 6 inches above the floor, are other 3 light windows of 10x12 glass. The building is boarded, papered and shingled all over the outside, roof and walls. The floor is of two thicknesses of hemlock boards. The entire inside of the building is papered on the studs and rafters and sheathed with matched boards. The work was carefully done and good dead air spaces were obtained over the whole building.

The building is divided into 15 ten foot sections. The close partitions between the pens are 2 feet high and are made of 2 inch plank. They form strong trusses, to which the studs supporting the central plate are strongly nailed. This saves the floor from sagging from the weight of the roof when it is covered with snow. An elevated plank walk, 4 feet wide, runs along the whole length of the front of the building and rests on the cross partitions just mentioned. The walk is 2½ feet above the floor and allows the hens to occupy the while floor space. This part of the floor is lighted from the front, by the small windows spoken of above. Above the close partition the pens are separated from each other and the walk by wire netting of 2 inch mesh. Light, wooden frame doors, covered with wire, and hung with double acting spring hinges, are in every cross partition, and also in the partition between the elevated walk and each pen.

The back ends of the cross partitions, 4 feet out from the back wall, are carried up to the roof, so as to protect the hens from

currents of air while on the roosts. The roost platform is along the back wall. Four trap nests described beyond, of our own devising and construction, are placed at the back of the house, at the end of the roost platform.

All the windows are double. Eight of the large outside ones are hinged at the top and kept hasped out one foot at the bottom, except in the roughest weather, and cold winter nights. This furnishes ventilation without drafts, as the position of the outside windows prevents strong currents of air from entering.

Although this house was thoroughly built, we found that the windows had to be closed during rough winter weather, or water would freeze quite hard inside the building. Closing the windows caused dampness and frost on the walls, and the straw litter absorbed the moisture and became, while yet clean, disagreeable to the hens. A hot water heater was placed in a pit at the lower end of the building, and one line of two inch pipe was carried under the roosts to the upper end of the building and returned to the boiler. By use of this heater the building is kept above the freezing point at all times, and there is not much trouble from moisture except when extremely cold weather necessitates the closing of the windows.

The birds in this house have always been in excellent health, and have never shrunk in their egg yields from cold weather except one season when coal was not procurable and the temperature ran low.

The ease with which the hens are cared for, the availability of the entire floor space, and the welfare and productiveness of the birds kept here, commends this building as one of the best. It was planned and constructed so as to obtain conditions necessary for the welfare of the birds and economize the labor involved in their care at as small cost as was consistent with quality. Not a single part was made for show. While a single walled building would have cost less, it would not have kept the hens warm or given protection from dampness, that prevails in close single-walled houses.

THE PIONEER ROOSTING CLOSET HOUSE.

A dozen years ago several little houses, each 10 feet square, were built for colonies of hens. They were well built and warm, but were apt to be damp and lined with white frost in very cold

weather, when the windows had to be kept shut to save the birds from suffering at night. Another feature against them was their size. A person cannot care for hens in so small a pen without keeping them in a condition of unrest, for they fear being cornered in so small a room. Three years ago one of these 10 feet square houses was taken for a nucleus and an addition made, so that the reconstructed house was 10 feet wide and 25 long. The end of the old house was taken out, so that there was one room with a floor space of 250 square feet. The walls were about 5½ feet high in the clear, inside of the building. The whole of the front wall was not filled in, but a space 3 feet wide and 15 feet long was left just under the plate. This space had a frame, covered with white drilling, hinged at the top on the inside, so it could be let down and buttoned during driving storms and winter nights, but hung up out of the way at all other times. The roost platform extended the whole length of the back of the room. It was 3 feet 4 inches wide and 3 feet above the floor. The back wall and up the roof for 4 feet was lined and packed hard with fine hay. The packing also extended part way across the ends of the room.

Two roosts were used, but they did not take the whole length of the platform, a space of 4 feet at one end being reserved for a crate where broody hens could be confined, until the desire for sitting should be overcome. The space, from the front edge of the platform up to the roof, was covered by frame curtains of drilling, similar to the one on the front wall. The cloth curtains were oiled with hot linseed oil. They were hinged at the top edge and kept turned up out of the way during day time, but from the commencement of cold weather until spring they were closed down every night after the hens went to roost. The hens were shut in to this close roosting closet and kept there nights, and released as early in the morning as they could see to scratch for the grain which was sprinkled in the 8 inch deep straw on the floor.

The roosting closet was closely observed and has never been damp, or its odors offensive when opened in the mornings. There was very little freezing in the closets in the coldest weather. The birds seemed to enjoy coming out of the warm sleeping closet down into the cold straw, which was never damp, but always dry, because the whole house was open to the out-

side air and sun every day. There were no shut off corners of floor or closet that were damp. We used this building through three winters, with 50 hens in it, and have not had a case of sickness in it yet. Not a case of cold or snuffles has developed from sleeping in the closet with its cloth front, and then going directly down into the cold room and spending the day in the open air.

The birds have laid as well as their mates in the large warmed house have done; averaging last year above 150 eggs each. Their combs have been red and their plumage bright, and they have given every evidence of perfect health and vigor. While they are on the roosts, in bed, they are warm. They come down to their breakfasts and spend the day in the open air. Such treatment gives vigor and snap to the human, and it seems to work equally well with the hen.

The results of the three years use of this house have been such that we feel very sure that this is one of the right systems of treatment and housing of hens, and it was decided to build several houses on the same plan and join them together under one roof, as one house.

THE CURTAIN FRONT HOUSE FOR HENS.

This building was erected in 1903 and is 14 feet wide and 150 feet long. The back wall is 5½ feet high from floor to top of plate inside, and the front wall is 6⅔ feet high. The roof is of unequal span, the ridge being 4 feet in from the front wall. The height of the ridge above the floor is 9 feet. The sills are 4x6 inches in size and rest on a rough stone wall laid on the surface of the ground. A central sill gives support to the floor which at times is quite heavily loaded with sand. The floor timbers are 2x8 inches in size and are placed 2 feet apart. The floor is two thicknesses of hemlock boards. All of the rest of the frame is of 2x4 inch stuff. The building is boarded, papered and shingled, on roof and walls. The rear wall and 4 feet of the lower part of the rear roof, are ceiled on the inside of the studding and plates, and packed, very hard, with dry sawdust. In order to make the sawdust packing continuous between the wall and roof, the wall ceiling is carried up to within 6 inches of the plate, then follows up inclining pieces of studding to the rafters.

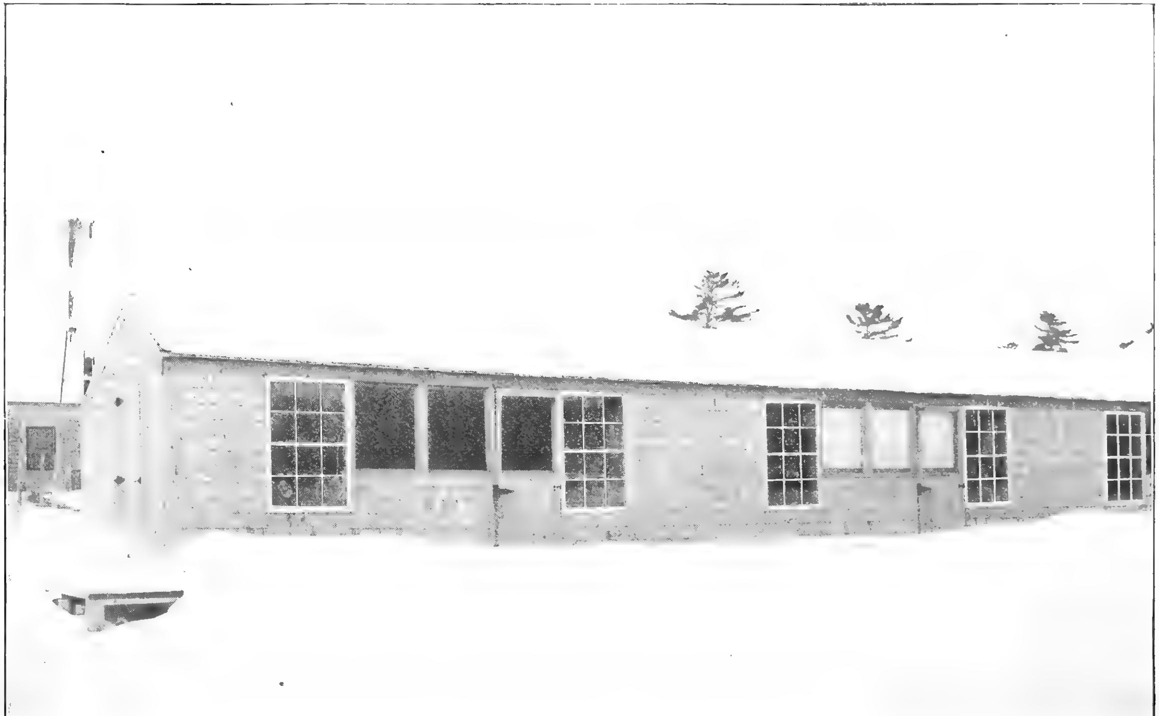


Fig. 5. TWO SECTIONS OF CURTAIN FRONT HOUSE.
Described on page 14.

The short pieses of studding are nailed to the studs and rafters. By this arrangement there are no slack places around the plate to admit cold air. The end walls are packed in the same way. The house is divided by close board partitions into seven 20 foot sections; and one 10 foot section is reserved at the lower end for a feed storage room.

Each of the 20 foot sections has two 12 light, outside windows screwed onto the front, and the space between the windows, which is 8 feet long, and 3 feet wide, down from the plate, is covered during rough winter storms and cold nights, by a light frame, covered with 10 ounce duck, closely tacked on. This door, or curtain is hinged at the top and swings in and up to the roof when open.

A door 2½ feet wide is in the front of each section. The roost platform is at the back side of each room and extends the whole 20 feet. The platform is 3 feet 6 inches wide and is 3 feet above the floor. The roosts are 2x3 inch stuff placed on edge and are 10 inches above the platform. The back one is 11 inches out from the wall and the space between the two is 16 inches, leaving 15 inches between the front roost and the duck curtain, which is sufficient to prevent the curtain being soiled by the birds on the roost. The two curtains in front of the roost are similar to the one in the front of the house. They are each 10 feet long and 30 inches wide, hinged at the top, and open out into the room and fasten up when not in use. Great care was exercised in constructing the roosting closets, to have them as near air tight as possible, excepting what may be admitted through the cloth curtain.

Single pulleys are hung at the rafters, and with half inch rope fastened to the lower edge of the curtain frames they are easily raised or lowered and kept in place. At one end of the roosts, a space of 3 feet is reserved for a cage for broody hens. This being behind the curtain, the birds have the same night temperature when they are transferred from the roosts to the cage.

Six trap nests are placed at one end of each room, and four at the other. They are put near the front so that the light may be good for reading and recording the number on the leg bands of the birds. Several shelves are put on the walls, 1½ feet above the floor, for shell, grit, bone, etc. The doors which admit from one room to another, throughout the building, are frames

covered with 10 ounce duck, so as to make them light. They are hung with double acting spring hinges. The advantages of having all doors push from a person are very great, as they hinder the passage of the attendant, with his baskets and pails, very little. Straps of old rubber belting are nailed around the studs which the doors rub against as they swing to, so as to just catch and hold them from opening too easily by the wind. Tight board partitions were used between the pens instead of wire, so as to prevent drafts. A platform 3 feet wide, extends across both ends and the entire front of the building, outside.

The house is well made of good material and should prove to be durable. It cost about $850. A rougher building with plain instead of trap nests, with the roof and walls covered with some of the prepared materials, instead of shingles, could be built for less money, and would probably furnish as comfortable quarters for the birds for a time, as this building will.

This house accommodates 350 hens—50 in each 20 foot section. It was not ready for occupancy until the 6th of December. Since then there has been some very severe weather, considerably below zero at night and about zero during the day, with a good deal of high wind. During this rough weather the bedding on the floor has kept comparatively dry; and the voidings on the platform as found when the curtains were raised in the mornings, have been but slightly frozen. The yields of eggs during this severe weather and the week immediately following it, were not below those immediately preceding it. It should be borne in mind that had the weather been mild during that time the hens probably would have increased in production rather than remain stationary. They were doubtless affected by the severe weather, but not seriously, as they began to increase in production very soon after the weather became usual for midwinter.

THE YARDS.

The yards to most poultry houses are at the south, or sheltered sides of the buildings, to afford protection during late fall and early spring, when cold winds are common. The north house has yards on both north and south sides with convenient gates. The south yards are used until the cold winds are over in spring, when they will go to the north yards, which are well set in grass sod. With the new curtain front south house the yards are to be

Fig. 6. INTERIOR OF ONE SECTION OF CURTAIN FRONT HOUSE.
Described on page 11.

on the north side only. The birds will be kept in the building until the weather is suitable for opening the small doors in the rear wall. The necessity for getting them out from the open front house, where they are really subject to most of the out of door conditions during the day time, is not so great as when they are confined in close houses, with walls and glass windows. The use of the rear yards only, may not prove satisfactory. If however, as good yields of eggs and health of birds result, many decided advantages will be obtained by dispensing with front yards. The clear open front of the house allows teams to pass close to the open door of the pens for cleaning out worn material, and delivering new bedding, and also in allowing attendants to enter and leave all pens from the outside walk, and reach the feed room without passing through intervening pens.

TRAP NESTS.

The nest which we use is original with us. It is very simple, inexpensive, easy to attend and certain in its action. It is a box-like structure without front end or cover, 28 inches long, 13 inches wide and 16 inches deep, inside measure. A division board with a circular opening 7½ inches in diameter is placed across the box, 12 inches from the rear end and 15 inches from the front end. The rear section is the nest proper. Instead of a close made door at the entrance, a light frame of 1 by 1½ inch stuff is covered with wire netting of one inch mesh. The door is 10 inches wide by 10 inches high, and does not fill the entire entrance, a space of two inches being left at the bottom, and one inch at the top, with a good margain at each side, to avoid friction. It is hinged at the top and opens up into the box. The hinges are placed on the front of the door rather than at the center or rear, the better to secure complete closing action. The trap consists of one piece of stiff wire about three-sixteenths of an inch in diameter and 22 inches long. This piece of wire is shaped so that a section of it, 11 inches long, rests directly across the circular opening in the division board and is held in place by two clamps, one on either side of the circular opening. The clamps fit loosely and the slots are long enough to allow the wire to work up and down about three inches, without much friction. The next section of the wire is eight inches long and it is bent

so that it is at right angles with the eleven inch section. It passes along the side of the box eleven inches above the floor, back toward the entrance door and is fastened strongly to the wall by staples, but yet loosely enough so that the wire can roll easily. The remaining section of the wire, which is three inches long, is bent toward the center of the box, with an upward inclination, so that it supports the door when it is open and rests upon it. The end of the wire is turned over smoothly, forming a notch into which the door may slip when opened.

As the hen passes in under the open door and then through the circular opening to the nest, she raises herself so that her keel may pass over the lower part of the division board, and her back presses against the horizontal wire, as she passes it, and lifts it enough, so that the end supporting the door slides from under it, and the door swings down and passes a wire spring, near the bottom of the box, at the entrance, which locks it and prevents the hen from escaping, and others from entering.

The double box with nest in rear is necessary, as when a hen has laid and desires to leave the nest, she steps out into the front space and remains there, generally trying to escape, until she is released. With one section only she would be very likely to crush her egg by stepping upon it and learn the pernicious habit of egg-eating.

The boxes are placed four in a block, and slide in and out like drawers and can be carried away for cleansing when necessary. Four nests in a pen have accommodated 20 hens, by the attendant going through the pens once an hour, or a little oftener, during that part of the day when the hens are busiest. Earlier and later in the day his visits have not been so frequent. To remove a hen, the nest is pulled part way out and as it has no cover, she is readily lifted up, and the number on her leg band is noted on the record sheet, that is tacked up, close at hand. After having been taken off a few times they do not object to being handled, the most of them remaining quiet, apparently expecting to be picked up.

Before commencing the use of trap nests, it was thought that some hens might be irritated by the trapping operation and object to the noise incident to it, but we have not found an individual that appeared to be annoyed by it, and we have used Leghorns, Brahmas, Wyandottes and Plymouth Rocks. The

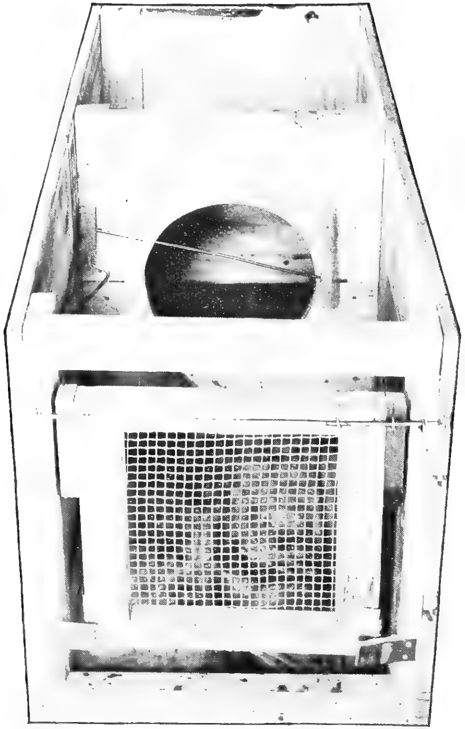


Fig. 7. Front and Top View.

Fig. 8. Front View.

TRAP RECORD NESTS DESCRIBED ON PAGE 17.

amount of time required in caring for the trap nests, so far as our work goes, can only be estimated, as the time varies from one day to another, and having only fifty-two nests in operation, the attendant's time was divided with other duties. By noting the total time used per day in caring for the nests, when the hens were laying most heavily, it is believed that one active person devoting his entire time to trap nests, like ours, would take care of 400 to 500 nests used by 2,000 to 2,500 hens. When commencing the year's work he would need assistance in banding the birds, but after that was done he could care for the nests without assistance until midsummer, when the egg yields would probably be diminished and a part of his time could be spared for other duties.

One of the first difficulties encountered was with the leg bands. We procured and used all of the bands that appeared to be durable, and not likely to be lost off. Several kinds were easily put on but would last only a few weeks or months before they would be loosening or breaking, and we finally adopted a make, that consists of a fairly broad metallic band encircling the leg, with the ends held together by small brass spring rings. These rings would sometimes get broken or lost out and we put in two instead of one. Even then, when hens were moulting, broody, or for other reasons not frequently handled and the rings examined, the bands would sometimes get off. Bands with duplicate numbers and double rings are now used on both legs and the likelihood of losing the identity of a bird is small.

When not using trap nests, the following is a very satisfactory nest. It is a foot wide, a foot high and three feet long with cover. A partition in the middle has an opening just large enough to admit the passage of a hen. The nest openings are away from the light and when a hen goes to the nest and looks in she blocks the opening and shuts out the light and does not see the eggs plainly. The temptation to meddle and break them is thus removed.

FEEDING THE HENS.

For twenty-one years we have been at work with the same family of Barred Plymouth Rocks and have learned one way to feed and handle them to secure eggs, and to avoid the losses which are so common to mature hens of that breed, from over

fatness. Other methods of feeding may be as good or even better. While it is true that only the full fed hen can lay to the limit of her capacity it is equally true that full feeding of the Plymouth Rocks, unless correctly done, results disastrously.

Years ago the "morning mash," which was regarded as necessary to "warm up the cold hen," so she could lay that day, was given up and it was fed at night. The birds are fed throughout the year daily as follows: Each pen of twenty-two receives one pint of wheat in the deep litter early in the morning. At 9.30 A. M. one-half pint of oats is fed to them in the same way. At 1 P. M. one-half pint of cracked corn is given in the litter as before. At 3 P. M. in winter and 4 P. M. in summer they are given all the mash they will eat up clean in half an hour. The mash is made of the following mixture of meals: 200 lbs. wheat bran; 100 lbs. corn meal; 100 lbs wheat middling; 100 lbs. linseed meal; 100 lbs. gluten meal; 100 lbs beef scrap. The mash contains one-fourth of its bulk of clover leaves and heads, obtained from the feeding floor in the cattle barn. The clover is covered with hot water and allowed to stand for three or four hours. The mash is made quite dry, and rubbed down with the shovel in mixing, so that the pieces of clover are separated and covered with the meal. Cracked bone, oyster shell, clean grit, and water are before them all of the time. Two large mangolds are fed to the birds in each pen daily in winter. They are struck on to large nails which are partly driven into the wall, a foot and a half above the floor. Very few soft shelled eggs are laid and, so far as known, not an egg has been eaten by the hens during the last five years.

We are testing another method of feeding with several pens of hens this year. It consists of the morning, 9.30 A. M., and 1 P. M. feedings of dry food in the litter as usual, but instead of the mash at 3 P. M. all the dry cracked corn they will eat is given in troughs. Beef scrap is kept before the birds at all times, in elevated troughs where they cannot waste it. They are supplied with grit, oyster shell, bone, and mangolds. Dry clover leaves and chaff are given them on the floor each day. One pen of 30 hens were fed through last year in this way with good results, and 150 hens are being fed on the dry food, through this year, in comparison with a like number of their mates that are having mash at the 3 P. M. feeding, as usual with us.

FERTILIZER INSPECTION.

CHAS. D. WOODS, Director.

J. M. BARTLETT, Chemist in Charge of Fertilizer Analysis.

The law regulating the sale of commercial fertilizers in this State calls for two bulletins each year. The first of these contains the analyses of the samples received from the manufacturer, guaranteed to represent, within reasonable limits, the goods to be placed upon the market later. The second bulletin contains the analyses of the samples collected in the open market by a representative of the Station.

In the tables which follow the discussion there are given the results of the analyses of the manufacturers' samples of licensed brands. The tables include all the brands which have been licensed to March 1, 1904. Dealers are cautioned against handling any brands not given in this list without first writing the Station.

The figures which are given as the percentages of valuable ingredients guaranteed by the manufacturers are the minimum percentages of the guarantee. If, for instance, the guarantee is 2 to 3 per cent of nitrogen, it is evident that the dealer cannot be held to have agreed to furnish more than 2 per cent and so this percentage is taken as actual guarantee. The figures under the head of "found" are those showing the actual composition of the samples.

To produce profitable crops and at the same time to maintain and even to increase the productive capacity of the soil may rightly be termed "good farming." Many farmers are able to do this, and the knowledge of how to do it has been largely acquired through years of experience, during which the character of the soil, its adaptability for crops, and the methods of its management and manuring have been made the subjects of careful study, without, however, any definite and accurate knowledge concerning manures and their functions in relation to soils and crops. To those who desire to study this question,

the Station will, on application, send a list of suitable books. Experience in the field, explained by experiments in the laboratory, has clearly demonstrated a few principles which underlie the successful and economical use of fertilizers.

Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils. The way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant-food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the questions to the soil with different fertilizing materials and get the reply in the crops produced. How to make these experiments is explained in Circular No. 8 of the Office of Experiment Stations of the U. S. Department of Agriculture. A copy of this circular can be had by applying to the Secretary of Agriculture, Washington, D. C., or to the Maine Agricultural Experiment Station.

The chief use of fertilizers is to supply plant-food. It is good farming to make the most of the natural resources of the soil and of the manures produced on the farm, and to depend upon artificial fertilizers only to furnish what more is needed. It is not good economy to pay high prices for materials which the soil may itself yield, but it is good economy to supply the lacking ones in the cheapest way. The rule in the purchase of costly commercial fertilizers should be to select those that supply, in the best forms and at the lowest cost, the plant-food which the crop needs and the soil fails to furnish.

Plants differ widely with respect to their capacities for gathering their food from soil and air; hence the proper fertilizer in a given case depends upon the crop as well as upon the soil. The fertility of the soil would remain practically unchanged if all the ingredients removed in the various farm products were restored to the land. This may be accomplished by feeding the crops grown on the farm to animals, carefully saving the manure and returning it to the soil. If it is practicable to pursue a system of stock feeding in which those products of the farm which are comparatively poor in fertilizing constituents are exchanged in the market for feeding stuffs of high fertilizing value, the loss of soil fertility may be reduced to a minimum or there may be an actual gain in fertility.

Constituents of Fertilizers.*

The only ingredients of plant-food which we ordinarily need to consider in fertilizers are potash, lime, sulphuric acid, phosphoric acid, and nitrogen. The available supply of sulphuric acid and lime is often insufficient; hence one reason for the good effect so often observed from the application of lime, and of plaster, which is a compound of lime and sulphuric acid. The remaining substances, nitrogen, phosphoric acid and potash, are the most important ingredients of our common commercial fertilizers, both because of their scarcity in the soil and their high cost. It is in supplying these that phosphates, bone manures, potash salts, guano, nitrate of soda, and most other commercial fertilizers are chiefly useful.

The term "form" as applied to a fertilizing constituent has reference to its combination or association with other constituents which may be useful, though not necessarily so. The form of the constituent, too, has an important bearing upon its availability, and hence upon its usefulness as plant food. Many materials containing the essential elements are practically worthless as sources of plant food because the form is not right; the plants are unable to extract them from their combinations; they are "unavailable." In many of these materials the forms may be changed by proper treatment, in which case they become valuable not because the element itself is changed, but because it then exists in such form as readily to feed the plant.

Nitrogen is the most expensive of the three essential fertilizing elements. It exists in three different forms, organic nitrogen, ammonia and nitrate.

Organic nitrogen exists in combination with other elements either as vegetable or animal matter. All materials containing organic nitrogen are valuable in proportion to their rapidity of decay, because change of form must take place before the nitrogen can serve as food. Organic nitrogen differs in availability not only according to the kind of material which supplies it, but according to the treatment it receives. The nitrogen in the tables of analyses marked "insoluble in water" is organic nitrogen.

* **Farmers Bulletin 44 of the U. S. Dept. of Agriculture, "Commercial Fertilizers, Composition and Use," can be had free by applying to your Congressman.**

Nitrogen as ammonia usually exists in commercial manures in the form of sulphate of ammonia and is more readily available than organic nitrogen. While nitrogen in the form of ammonia is extremely soluble in water, it is not readily removed from the soil by leaching as it is held by the organic compounds of the soil.

Nitrogen as nitrate exists in commercial products chiefly as nitrate of soda. Nitrogen in this form is directly and immediately available, no further changes being necessary. It is completely soluble in water, and diffuses readily throughout the soil. It differs from the ammonia compounds in forming no insoluble compounds with soil constituents and may be lost by leaching. The "Nitrogen soluble in water" of the tables includes both the nitrogen as ammonia and as nitrate.

Phosphoric acid is derived from materials called phosphates, in which it may exist in combination with lime, iron, or alumina as phosphates of lime, iron or alumina. Phosphate of lime is the form most largely used as a source of phosphoric acid. Phosphoric acid occurs in fertilizers in three forms: That soluble in water and readily taken up by plants; that insoluble in water, but still readily used by plants, also known as "reverted;" and that soluble only in strong acids and consequently very slowly used by the plant. The "soluble" and "reverted" together constitute the "available" phosphoric acid. The phosphoric acid in natural or untreated phosphates is insoluble in water, and not readily available to plants. If it is combined with organic substance, as in animal bone, the rate of decay is more rapid than if with purely mineral substances. The insoluble phosphates may be converted into soluble forms by treatment with strong acids. Such products are known as acid phosphates or superphosphates. The "insoluble phosphoric acid" of a high cost commercial fertilizer has little or no value to the purchaser because at the usual rate of application the quantity is too small to make any perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal amount of more needful and valuable constituents.

Potash in commercial fertilizers exists chiefly as muriates and sulphates. With potash the form does not exert so great an influence upon availability as is the case with nitrogen and phosphoric acid. All forms are freely soluble in water, and are

believed to be nearly if not quite equally available as food. The form of the potash has an important influence upon the quality of certain crops. For example, the results of experiments seem to indicate that the quality of tobacco, potatoes, and certain other crops is unfavorably influenced by the use of muriate of potash, while the same crops show a superior quality if materials free from chlorides have been used as the source of potash.

Valuation of Fertilizers.

The agricultural value of any of the fertilizing constituents is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituents, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value," or cost in market. This value is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $20 to $45 per ton are paid, depend for their trade value exclusively on the sub-

stances, nitrogen, phosphoric acid and potash, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If anyone wishes to calculate the commercial value he can do so by using the trade values adopted for 1904 by the Experiment Stations of Connecticut, Massachusetts, Rhode Island and New Jersey. These valuations represent the average retail prices at which these ingredients could be purchased during the three months preceding March 1, 1904, in ton lots at tide water in the states named. On account of the greater distance from the large markets the prices for Maine at tide water would probably be somewhat higher than those quoted.

TRADE VALUES OF FERTILIZING INGREDIENTS FOR 1904.

	Cents per pound
Nitrogen in nitrates	16
in ammonia salts	17½
Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers	17½
in fine bone and tankage	17
in coarse bone and tankage	12½
Phosphoric acid, water-soluble	4½
citrate-soluble	4
of fine ground bone and tankage	4
of coarse bone and tankage	3
of cotton seed meal, castor pomace, and ashes	4
of mixed fertilizers, if insoluble in ammonium citrate	2
Potash as high grade sulphate and in forms free from muriate (or chlorides)	5
as muriate	4¼

The commercial valuation will be accurate enough as a means of comparison if the following rule is adopted:

Multiply 3.5 by the percentage of nitrogen.

Multiply 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.0 by the percentage of potash.

The sum of these four products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 2.00 per cent; Available phosphoric acid 8.50 per cent; Insoluble phosphoric acid 3.50 per cent; Potash 3.25 per sent. The valuation in this case will be computed thus:

Nitrogen,	3.5×2.00,	7.00
Available phosphoric acid,	.8×8.50,	6.80
Insoluble phosphoric acid,	0.4×3.50,	1.40
Potash,	1.0×3.25,	3.25
Valuation per ton,		$18.45

Since this rule assumes all the nitrogen to be organic and all the potash to be in the form of the sulphate, it is evident that the valuations thus calculated must not be taken as the only guide in the choice of a fertilizer. At best the valuations can only serve to show the approximate cost of the several ingredients contained in the fertilizer in question. In every case the farmer should consider the needs of his soil before he begins to consider the cost. In many instances a little careful experimenting will show him that materials containing either nitrogen, potash, or phosphoric acid alone will serve his purpose as fully as a "complete fertilizer," in which he must pay for all three constituents, whether needed or not.

The results of the analyses of the manufacturers' samples of fertilizers are given on the following pages.

DESCRIPTIVE LIST OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.
	THE AMERICAN AGRICULTURAL CHEM. CO., NEW YORK, N. Y.
3152	Bradley's Akaline Bone with Potash
3153	Bradley's Complete Manure for Potatoes and Vegetables
3154	Bradley's Complete Manure with 10% Potash
3155	Bradley's Corn Phosphate
3156	Bradley's Eureka Fertilizer
3157	Bradley's Niagara Phosphate
3158	Bradley's Potato Fertilizer
3159	Bradley's Potato Manure
3160	Bradley's X. L. Superphosphate of Lime
3161	Clark's Cove Bay State Fertilizer
3162	Clark's Cove Bay State Fertilizer, G. G.
3163	Clark's Cove Bay State Fertilizer for Seeding Down
3164	Clark's Cove Defiance Complete Manure
3165	Clark's Cove Great Planet Manure, A. A
3166	Clark's Cove King Philip Alkaline Guano
3167	Clark's Cove Potato Fertilizer
3168	Clark's Cove Potato Manure
3169	Cleveland Fertilizer for All Crops
3170	Cleveland High Grade Complete Manure
3171	Cleveland Potato Phosphate
3172	Cleveland Seeding Down Fertilizer
3173	Cleveland Superphosphate
3174	Complete Manure with 10% Potash
3175	Crocker's Aroostook Potato Special
3176	Crocker's Corn Phosphate
3177	Crocker's Grass and Oats Fertilizer
3178	Crocker's New Rival Ammoniated Superphosphate
3179	Crocker's Potato, Hop and Tobacco
3180	Crocker's Special Potato Manure
3181	Cumberland Guano for All Crops
3182	Cumberland Potato Fertilizer
3183	Cumberland Seeding Down Manure
3184	Cumberland Superphosphate
3185	Darling's Blood, Bone and Potash
3186	Great Eastern General Fertilizer
3187	Great Eastern Grass and Oats Fertilizer
3188	Great Eastern High Grade Potato Manure
3189	Great Eastern Northern Corn Special
3190	Great Eastern Potato Manure
3191	High Grade Fertilizer with 10% potash
3192	Lazaretto Aroostook Potato Guano
3193	Lazaretto Corn Guano
3194	Lazaretto High Grade Potato Guano
3195	Lazaretto Propeller Potato Guano
3196	Lazaretto Wheat, Oats and Clover Fertilizer

ANALYSES OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3152	......	......	......	......	6.27	4.51	2.60	10.78	11.00	13.38	12.00	2.01	2.00
3153	1.06	2.40	3.46	3.30	5.36	3.32	1.51	8.68	8.00	10.19	9.00	6.91	7.00
3154	1.99	1.31	3.30	3.30	3.59	3.19	2.44	6.78	6.00	9.22	7.00	11.20	10.00
3155	0.66	1.42	2.08	2.06	7.05	2.55	2.56	9.60	8.00	12.16	10.00	2.01	1.50
3156	0.11	1.06	1.17	1.03	5.93	2.35	1.55	8.28	8.00	9.83	10.00	2.32	2.00
3157	0.40	0.64	1.04	0.82	5.41	3.15	1.38	8.56	7.00	9.94	8.00	1.49	1.00
3158	0.77	1.22	1.99	2.06	5.74	4.74	2.54	10.48	8.00	13.02	10.00	3.17	3.00
3159	0.81	1.58	2.39	2.50	2.89	3.80	3.18	6.69	6.00	9.87	8.00	5.15	5.00
3160	1.10	1.36	2.46	2.50	6.74	3.16	1.80	9.90	9.00	11.70	11.00	2.68	2.00
3161	1.14	1.32	2.46	2.50	7.26	3.08	1.80	10.34	9.00	12.14	11.00	2.35	2.00
3162	0.62	1.40	2.02	2.06	7.21	2.42	2.36	2.63	8.00	11.99	10.00	1.95	1.50
3163	0.41	0.74	1.15	1.03	5.93	2.80	2.42	8.73	8.00	11.15	10.00	2.57	2.00
3164	0.40	0.68	1.08	0.82	5.24	2.74	1.48	7.98	7.00	9.46	8.00	1.59	1.00
3165	1.88	1.52	3.40	3.30	5.20	3.01	1.96	8.21	8.00	10.17	9.00	7.43	7.00
3166	0.43	0.68	1.11	1.03	5.71	2.67	1.47	8.38	8.00	9.85	10.00	2.12	2.00
3167	0.91	1.03	1.94	2.06	6.49	5.31	0.40	11.80	8.00	12.20	10.00	3.35	3.00
3168	0.56	2.11	2.67	2.50	3.96	3.03	3.49	6.99	6.00	10.48	8.00	5.59	5.00
3169	0.34	0.72	1.06	1.03	5.50	2.87	2.60	8.37	8.00	10.97	10.00	2.30	2.00
3170	2.02	1.21	3.23	3.30	4.96	3.41	2.27	8.37	8.00	10.64	9.00	7.53	7.00
3171	0.62	1.34	1.96	2.06	5.95	3.99	2.74	9.94	8.00	12.68	10.00	3.03	3.00
3172	0.11	1.06	1.17	1.03	5.79	2.89	1.27	8.68	8.00	9.95	10.00	2.20	2.00
3173	0.66	1.40	2.06	2.06	7.17	2.35	2.62	9.52	8.00	12.14	10.00	2.03	1.50
3174	1.34	1.72	3.06	3.30	3.84	2.33	2.11	6.17	6.00	8.28	7.00	10.19	10.00
3175	0.81	1.29	2.10	2.06	5.17	3.33	2.03	8.50	8.00	10.53	......	6.61	6.00
3176	0.26	2.06	2.32	2.06	4.52	3.65	3.87	8.17	8.00	12.04	.....	2.26	1.50
3177	......	......	......	......	7.54	4.28	1.79	11.82	11.00	13.61	......	2.03	2.00
3178	0.23	1.14	1.37	1.03	4.82	3.70	2.47	8.52	8.00	10.99	.....	2.12	2.00
3179	1.10	1.10	2.20	2.06	5.98	2.07	2.68	8.05	8.00	10.73	.....	3.34	3.00
3180	2.01	1.30	3.31	3.29	3.84	3.29	2.34	7.13	6.00	9.47	......	10.80	10.00
3181	0.03	1.23	1.26	1.03	6.22	3.00	2.49	9.22	8.00	11.71	10.00	2.28	2.00
3182	0.72	1.34	2.06	2.06	6.13	4.17	2.33	10.30	8.00	12.63	10.00	3.38	3.00
3183	0.44	0.72	1.16	1.03	5.42	2.98	2.53	8.40	8.00	10.93	10.00	2.53	2.00
3184	0.56	1.38	1.94	2.06	7.01	2.38	2.55	9.39	8.00	11.94	10.00	2.35	1.50
3185	2.26	1.64	3.90	4.10	2.81	4.44	2.40	7.25	7.00	9.65	8.00	7.41	7.00
3186	*	*	1.10	0.82	0.69	9.25	2.26	9.94	8.00	12.20	......	4.72	4.00
3187	.....	......	......	.....	4.11	6.88	4.08	10.99	11.00	15.07	......	2.15	2.00
3188	2.38	1.00	3.38	3.29	4.87	3.25	1.86	8.12	6.00	9.98	......	10.64	10.00
3189	0.42	1.84	2.26	2.06	5.02	4.60	2.35	9.62	8.00	11.98	......	2.26	1.50
3190	0.85	1.23	2.08	2.06	5.92	2.31	2.76	8.23	8.00	10.99	......	3.37	3.00
3191	1.50	1.03	2.53	2.40	5.82	1.76	2.63	7.58	6.00	10.21	7.00	10.44	10.00
3192	0.19	0.78	0.97	0.82	5.69	3.36	2.11	9.05	8.00	11.16	......	4.57	4.00
3193	0.95	1.02	1.97	1.64	4.47	3.20	2.74	7.67	8.00	10.41	.....	2.53	2.00
3194	1.21	1.82	3.03	3.29	4.00	1.90	2.27	5.90	6.00	8.17	......	10.60	10.00
3195	0.70	1.30	2.00	2.06	5.69	2.56	2.88	8.25	8.00	11.13	......	6.52	6.00
3196	.....	......	......	......	8.60	3.56	1.00	12.16	11.00	13.16	.....	2.78	2.00

* Undetermined.

DESCRIPTIVE LIST OF MANUFACTURERS' SAMPLES, 1904.

Station Number.	Manufacturer, place of business and brand.
3197	Otis' Potato Fertilizer
3198	Otis' Seeding Down Fertilizer
3199	Otis' Superphosphate
3200	Pacific Dissolved Bone and Potash
3201	Pacific Grass and Grain Fertilizer
3202	Pacific High Grade General Fertilizer
3203	Pacific Nobsque Guano
3204	Pacific Potato Special
3205	Packers Union Animal Corn Fertilizer
3209	Packers Union Economical Vegetable Guano
3206	Packers Union Gardeners Complete Manure
3207	Packers Union Potato Manure
3208	Packers Union Universal Fertilizer
3210	Packers Union Wheat, Oats and Clover Fertilizer
3211	Quinnipiac Climax Phosphate for All Crops
3212	Quinnipiac Corn Manure
3213	Quinnipiac Market Garden Manure
3214	Quinnipiac Mohawk Fertilizer
3215	Quinnipiac Potato Manure
3216	Quinnipiac Potato Phosphate
3217	Quinnipiac Seeding Down Manure
3218	Read's Farmer's Friend
3219	Read's High Grade Farmer's Friend
3220	Read's Potato Manure
3221	Read's Practical Potato Special
3222	Read's Standard Superphosphate
3223	Read's Sure Catch Fertilizer
3224	Read's Vegetable and Vine Fertilizer
3225	Soluble Pacific Guano
3226	Standard A Brand
3227	Standard Bone and Potash
3228	Standard Complete Manure
3229	Standard Fertilizer
3230	Standard Guano for All Crops
3231	Standard Special for Potatoes
3232	Williams and Clark's Americus Ammoniated Bone Superphosphate
3233	Williams and Clark's Americus Corn Phosphate
3234	Williams and Clark's Americus High Grade Special
3235	Williams and Clark's Americus Potato Manure
3236	Williams and Clark's Americus with 10% Potash
3237	Williams and Clark's Royal Bone Phosphate for All Crops
	THE BOWKER FERTILIZER CO., BOSTON, MASS.
3238	Bowker's Bone and Potash Square Brand
3239	Bowker's Corn Phosphate
3240	Bowker's Early Potato Manure
3241	Bowker's Farm and Garden Phosphate
3242	Bowker's Fresh Ground Bone
3243	Bowker's Hill and Drill Phosphate

ANALYSES OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.					Available.		Total.			
	Soluble in water.	Insoluble in water.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3197	0.77	1.22	1.99	2.06	5.68	5.03	2.42	10.71	8.00	13.13	10.00	3.20	3.00
3198	0.49	0.62	1.11	1.03	5.46	2.89	1.35	8.35	8.00	9.70	10.00	1.56	2.00
3199	0.68	1.38	2.06	2.06	6.94	2.92	2.43	9.86	8.00	12.29	10.00	2.16	1.50
3200	......	......	......	......	5.98	4.81	1.91	10.79	10.00	12.70	11.00	2.43	2.00
3201	0.42	0.64	1.06	0.82	5.46	3.01	1.43	8.47	7.00	9.90	8.00	2.99	1.00
3202	2.13	1.41	3.54	3.30	5.15	2.92	2.14	8.07	8.00	10.21	9.00	7.18	7.00
3203	0.40	0.66	1.06	1.03	5.52	2.66	1.63	8.18	8.00	9.81	10.00	1.97	2.00
3204	0.76	1.34	2.10	2.06	5.69	4.27	2.70	9.96	8.00	12.66	10.00	3.15	3.00
3205	0.31	2.10	2.41	2.47	5.64	3.22	3.46	8.86	9.00	12.32	......	1.91	2.00
3209	0.26	1.47	1.68	1.25	4.65	2.55	2.15	7.20	6.00	9.35	.....	3.59	3.00
3206	1.38	1.16	2.54	2.47	5.58	0.47	2.06	6.05	6.00	8.11	......	10.99	10.00
3207	0.96	1.10	2.06	2.06	4.85	3.16	1.85	8.01	8.00	9.86	.....	6.54	6.00
3208	0.25	0.96	1.21	0.82	6.05	3.22	1.46	9.27	8.00	10.73	......	5.04	4.00
3210	......	.....	......	....	.....	......	1.20	10.92	11.00	12.12	....	2.39	2.00
3211	0.39	1.06	1.45	1.03	5.10	3.54	1.63	8.64	8.00	10.27	10.00	2.91	2.00
3212	0.67	1.38	2.05	2.06	6.69	2.63	2.41	9.32	8.00	11.73	10.00	1.95	1.50
3213	2.19	1.39	3.58	3.30	4.23	4.67	1.47	8.90	8.00	10.37	9.00	7.57	7.00
3214	0.03	0.83	0.86	0.82	2.60	4.87	3.86	7.47	7.00	11.33	8.00	1.58	1.00
3215	1.03	1.50	2.53	2.50	2.55	4.03	3.06	6.58	6.00	9.64	8.00	5.15	5.00
3216	0.74	1.30	2.04	2.06	5.61	4.71	2.36	10.32	8.00	12.68	10.00	3.34	3.00
3217	0.39	0.64	1.03	1.03	5.44	3.14	1.46	8.85	8.00	10.04	10.00	2.61	2.00
3218	0.81	1.05	1.86	2.06	6.41	2.92	2.49	9.33	8.00	11.82	10.00	3.33	3.00
3219	1.60	1.58	3.18	3.30	3.89	2.20	2.17	6.09	6.00	8.26	7.00	10.02	10.00
3220	0.42	2.28	2.70	2.40	4.59	1.89	1.25	6.48	6.00	7.73	7.00	10.94	10.00
3221	0.42	0.74	1.16	0.82	1.64	2.56	1.99	4.20	4.00	6.19	5.00	8.03	8.00
3222	0.10	0.94	1.04	0.82	5.87	2.89	2.23	8.76	8.00	10.99	10.00	4.81	4.00
3223	....	.....	....	......	4.46	5.17	1.58	9.81	10.00	11.39	11.00	1.91	2.00
3224	0.32	1.80	2.12	2.06	5.94	2.25	1.38	8.29	8.00	9.67	10.00	6.35	6.00
3225	0.52	1.46	1.98	2.06	6.72	2.72	2.32	9.44	8.00	11.76	10.00	1.91	1.50
3226	0.31	0.90	1.21	0.82	3.64	4.10	2.08	7.74	7.00	9.82	8.00	1.56	1.00
3227	.....	.....	....	....	7.66	2.60	1.96	10.26	10.00	12.22	11.00	2.08	2.00
3228	2.40	0.90	3.30	3.30	7.02	1.99	1.04	8.81	8.00	9.85	9.00	7.56	7.00
3229	0.60	1.42	2.02	2.06	6.82	2.43	2.55	9.25	8.00	11.80	10.00	2.01	1.50
3230	0.37	0.70	1.07	1.03	5.31	3.03	1.44	8.34	8.00	9.74	10.00	2.10	2.00
3231	0.82	1.20	2.02	2.06	5.65	5.16	2.40	10.81	8.00	13.21	10.00	2.93	3.00
3232	0.95	1.32	2.27	2.50	6.72	3.08	1.94	9.80	9.00	11.74	11.00	2.35	2.00
3233	0.56	1.42	1.98	2.06	6.75	2.85	2.29	9.60	8.00	11.89	10.00	1.95	1.50
3234	2.15	1.39	3.54	3.30	3.80	4.10	2.15	7.90	8.00	10.05	9.00	7.48	7.00
3235	0.64	1.32	1.96	2.06	5.52	4.89	2.23	10.41	8.00	12.64	10.00	3.03	3.00
3236	0.96	1.18	2.14	2.40	4.18	2.29	1.67	6.47	6.00	8.14	7.00	10.62	10.00
3237	0.29	0.82	1.11	1.03	5.47	3.14	2.55	8.61	8.00	11.16	10.00	2.59	2.00
3238	1.03	0.81	1.84	1.65	1.04	3.68	7.10	4.72	6.00	11.82	7.00	2.34	2.00
3239	0.40	1.14	1.54	1.65	2.27	5.90	2.19	8.17	8.00	10.36	9.00	2.52	2.00
3240	1.19	1.95	3.14	3.29	3.57	3.49	2.23	7.06	7.00	9.29	8.00	7.33	7.00
3241	0.52	1.16	1.68	1.65	2.30	6.62	2.50	8.92	8.00	11.42	9.00	2.80	2.00
3242	......	.....	2.50	2.47	......	......	......	.....	.....	19.09	18.00	......	......
3243	0.71	1.73	2.44	2.47	3.27	5.48	2.76	8.75	9.00	11.51	10.00	2.16	2.00

DESCRIPTIVE LIST OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.
3244	Bowker's Market Garden Fertilizer
3245	Bowker's Potash Bone
3246	Bowker's Potash or Staple Phosphate
3247	Bowker's Potato and Vegetable Fertilizer
3248	Bowker's Potato and Vegetable Phosphate
3249	Bowker's Six Per Cent Fertilizer
3250	Bowker's Superphosphate with Potash for Grass and Grain
3251	Bowker's Sure Crop Phosphate
3252	Bowker's Ten Per Cent Manure
3253	Stockbridge Corn and Grain Manure
3254	Stockbridge Potato Manure
3255	Stockbridge Seeding Down Manure
	E. FRANK COE CO., NEW YORK CITY, N. Y.
3266	E. Frank Coe's Celebrated Special Potato Fertilizer
3256	E. Frank Coe's Columbian Corn Fertilizer
2257	E. Frank Coe's Columbian Potato Fertilizer
3258	E. Frank Coe's Excelsior Potato Fertilizer
3259	E. Frank Coe's Grass and Grain Fertilizer
3260	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
3261	E. Frank Coe's High Grade Potato Fertilizer
3262	E. Frank Coe's New Englander Corn Fertilizer
3263	E. Frank Coe's New Englander Potato Fertilizer
3264	E. Frank Coe's Prize Brand Grain and Grass Fertilizer
3265	E. Frank Coe's Red Brand Excelsior Guano
3267	E. Frank Coe's Standard Grade Ammoniated Bone Superphosphate
	JOHN WATSON COMPANY, HOULTON, ME.
3268	Watson's Improved High Grade Potato Manure
	LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
3269	Lister's Animal Bone and Potash
3270	Lister's High Grade Special for Spring Crops
3271	Lister's Oneida Special
3272	Lister's Potato Manure
3273	Lister's Special Corn Fertilizer
3274	Lister's Special Potato Fertilizer
3275	Lister's Success Fertilizer
	NATIONAL FERTILIZER CO., BRIDGEPORT, CONN.
3276	Chittenden's Ammoniated Bone Phosphate*
3277	Chittenden's Complete Root*
3278	Chittenden's Market Garden
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
3279	New England Corn and Grain Fertilizer
3280	New England Corn Phosphate
3281	New England High Grade Potato Fertilizer
3282	New England Potato Fertilizer
3283	New England Superphosphate

* Samples not received.

ANALYSES OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3244	.....	.....	.....	2.47	....	.....	.....	.....	6.00	.....	7.00	.....	10.00
3245	0.90	.....	0.90	0.82	3.05	1.93	3.03	4.98	6.00	8.01	7.00	2.10	2.00
3246	0.18	0.74	0.92	0.82	1.69	6.43	2.15	8.12	8.00	10.27	9.00	3.37	3.00
3247	0.61	1.73	2.34	2.47	7.26	2.32	0.83	9.58	8.00	10.41	10.00	4.30	4.00
3248	0.30	1.18	1.48	1.65	2.28	6.79	2.31	9.07	9.00	11.38	10.00	2.32	2.00
3249	0.35	0.65	1.00	0.82	1.39	4.82	3.05	6.21	6.00	9.26	7.00	6.48	6.00
3250	.....	.....	.....	.....	4.39	5.30	1.71	9.69	10.00	11.40	11.00	2.84	2.00
3251	0.35	0.72	1.07	0.82	4.93	3.50	2.42	8.43	9.00	10.85	10.00	2.37	2.00
3252	0.17	0.69	0.86	0.82	1.29	3.92	1.99	5.21	5.00	7.20	6.00	10.34	10.00
3253	1.29	1.97	3.26	3.29	3.51	1.59	2.04	8.10	7.00	10.14	8.00	7.24	7.00
3254	1.32	1.88	3.20	3.29	2.57	3.54	2.27	6.11	6.00	8.38	7.00	10.34	10.00
3255	0.79	1.59	2.38	2.47	2.97	2.88	4.24	5.85	6.00	10.09	9.00	10.04	10.00
3266	1.26	0.62	1.88	1.65	7.34	1.19	2.71	8.53	8.00	11.24	9.50	4.73	4.00
3256	0.60	0.74	1.34	1.23	7.29	2.77	2.53	9.46	8.50	12.01	10.50	2.98	2.50
3257	0.54	0.80	1.34	1.23	6.30	2.16	2.49	9.46	8.50	11.95	10.50	3.08	2.50
3258	1.46	0.96	2.42	2.50	6.03	1.97	2.22	8.00	7.00	10.22	9.00	9.35	8.00
3259	0.07	0.73	0.80	0.80	6.73	2.57	2.81	9.30	8.50	12.11	10.00	2.28	1.50
3260	1.02	1.06	2.08	1.85	6.76	2.26	2.30	9.02	9.00	11.32	13.00	3.09	2.25
3261	1.68	0.92	2.60	2.40	7.15	1.53	2.76	8.68	7.50	11.44	....	6.48	6.00
3262	0.63	0.70	1.33	0.80	7.15	2.42	2.60	9.57	7.50	12.17	8.50	3.11	3.00
3263	0.37	0.66	1.03	0.80	6.09	2.36	2.78	8.45	7.50	11.23	8.50	3.28	3.00
3264	......	......	......	......	6.64	3.96	3.06	10.55	10.50	13.61	12.00	2.59	2.00
3265	2.30	1.07	3.37	3.40	7.59	2.14	1.77	9.73	9.00	11.50	11.00	6.74	6.00
3267	0.63	0.56	1.19	1.20	6.03	2.50	2.70	8.53	8.50	11.23	10.00	3.90	2.00
3268	1.70	1.20	2.90	3.00	4.37	1.50	.75	5.87	6.00	6.62	9.00	5.23	5.00
3269	......	......	.....	....	7.07	2.96	2.04	10.03	10.00	12.07	......	2.93	2.00
3270	0.45	1.50	1.95	1.65	3.75	4.34	3.07	8.09	8.00	11.16	10.00	11.16	10.00
3271	0.34	0.83	1.17	0.82	4.42	3.71	2.48	8.13	7.00	10.61	8.00	1.16	1.00
3272	1.92	1.25	3.17	3.30	5.50	2.46	3.09	7.96	8.00	11.05	9.00	7.22	7.00
3273	0.70	1.12	1.82	1.65	5.63	3.72	2.39	9.35	8.00	11.74	9.00	3.66	3.00
3274	0.64	1.22	1.86	1.65	5.66	3.94	2.19	9.60	8.00	11.79	9.00	3.52	3.00
3275	0.31	0.99	1.30	1.24	6.16	3.02	2.58	9.18	9.00	11.76	11.00	2.37	2.00
3276				1.70					8.00		10.00		2.00
3277				3.30					8.00		10.00	......	6.00
3278	1.16	1.26	2.42	2.40	3.70	2.49	2.17	6.19	6.00	8.36	8.00	5.63	5.00
3279	0.44	0.76	1.20	1.22	5.66	1.40	0.55	7.06	7.00	7.61	8.00	2.05	2.00
3280	0.76	1.02	1.78	1.64	3.85	4.93	1.33	8.78	8.00	10.11	9.00	3.23	3.00
3281	1.28	1.20	2.48	2.46	5.65	2.38	2.16	8.03	8.00	10.19	9.00	6.18	6.00
3282	0.88	0.88	1.76	1.64	3.46	4.89	0.98	8.35	7.00	9.33	8.00	4.28	4.00
3283	1.24	1.24	2.48	2.46	7.58	1.63	1.05	9.21	9.00	10.26	10.00	4.54	4.00

DESCRIPTIVE LIST OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.
	THE PARMENTER & POLSEY FERTILIZER CO., PEABODY, MASS.
3284	A A Brand Fertilizer
3285	Aroostook Special Brand
3286	Grain Grower Brand
3287	Ground Bone Brand
3288	P. & P. Potato Brand
3289	Plymouth Rock Brand
3290	Special Potato Brand
3291	Star Brand Superphosphate
	PORTLAND RENDERING CO., PORTLAND, ME.
3292	Bone Tankage
	PROVINCIAL CHEMICAL FERTILIZER CO., LIMITED, ST. JOHN, N. B.
3293	Potato Phosphate
	RUSSIA CEMENT CO., GLOUCESTER, MASS.
3294	Essex A 1 Superphosphate
3295	Essex Complete Manure for Corn, Grain and Grass
3296	Essex Complete Manure for Potatoes, Roots and Vegetables
3297	Essex Corn Fertilizer
3298	Essex Market Garden and Potato Manure
3299	Essex XXX Fish and Potash
	SAGADAHOC FERTLIZER CO., BOWDOINHAM, ME.
3300	Aroostook Potato Manure *
3301	Dirigo Fertilizer
3302	Sagadahoc High Grade Superphosphate
3303	Special Clover Fertilizer
3304	Sagadahoc Special Potato Fertilizer*
3305	XX Chemicals
3306	Yankee Fertilizer
3307	Acid Phosphate
3308	Muriate of Potash
3309	Nitrate of Soda
	THE SCIENTIFIC FERTILIZER CO., PITTSBURG, PA.
3317	Scientific "Bone, Meat and Potash"
3318	Scientific "Corn and Grain"
3319	Scientific "Economy"
3320	Scientific Potato Fertilizer
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.
3310	Swift's Lowell Animal Brand
3311	Swift's Lowell Bone Fertilizer
3312	Swift's Lowell Cereal Fertilizer
3313	Swift's Lowell Dissolved Bone and Potash
3314	Swift's Lowell Ground Bone
3315	Swift's Lowell Potato Manure
3316	Swift's Lowell Potato Phosphate

* Samples received too late for analysis.

ANALYSES OF MANUFACTURERS' SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.					Available.		Total.			
	Soluble in water.	Insoluble in water.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3284	2.93	0.92	3.85	4.10	2.81	4.75	0.64	7.56	7.00	8.20	8.00	8.79	8.00
3285	2.49	1.16	3.65	3.70	4.33	3.21	0.66	7.54	7.00	8.20	8.00	10.33	10.00
3286	0.59	0.61	1.20	0.82	3.30	4.45	4.32	7.75	7.00	12.07	8.00	2.70	2.00
3287	.....	.....	1.80	2.47	.....	......	......	.....	5.00	20.13	23.00	.....	......
3288	1.00	0.84	1.84	1.64	2.36	5.15	0.99	7.51	6.00	8.50	7.00	6.91	6.00
3289	0.21	2.08	2.29	2.47	3.81	4.21	1.38	8.02	8.00	9.40	9.00	4.19	4.00
3290	1.69	1.29	2.98	3.29	4.21	4.27	1.29	8.48	8.00	9.77	9.00	7.41	7.00
3291	1.01	0.79	1.80	1.64	3.80	3.54	1.15	7.34	7.00	8.49	8.00	2.60	2.50
3292	2.69	3.43	6.12	5.30	....	....	4.85	9.57	7.10	14.42	15.30	....	......
3293	0.38	1.38	1.76	1.23	5.76	1.18	4.54	6.94	8.00	11.48	......	7.34	6.50
3294	0.18	1.34	1.52	1.00	1.96	5.32	4.93	7.29	7.00	12.22	9.00	2.11	2.00
3295	0.97	2.91	3.88	3.30	5.90	3.75	1.50	9.65	7.00	11.15	9.50	9.36	9.50
3296	0.96	3.22	4.18	3.70	6.33	2.62	3.14	8.95	7.00	12.09	9.00	8.39	8.50
3297	0.52	1.72	2.24	2.00	5.31	4.03	4.14	9.34	8.50	13.48	10.50	3.33	3.00
3298	0.79	1.55	2.34	2.00	5.25	5.17	2.65	10.42	8.00	13.07	10.00	5.06	5.00
3299	0.56	1.82	2.38	2.10	6.14	2.70	3.28	8.84	9.00	12.12	12.00	4.11	2.25
3300	....	......	......	1.25	....	....	.....	......	6.00	......	7.00	....	4.00
3301	......	1.02	1.02	1.10	2.04	3.13	5.74	5.17	6.00	10.91	10.00	4.04	2.00
3302	1.04	1.01	2.05	2.00	4.21	4.13	1.79	8.34	6.00	10.13	7.00	5.16	3.00
3303	0.45	0.75	1.20	0.85	3.94	6.20	2.76	10.14	7.00	12.90	8.00	.....	......
3304	......	.....	......	2.25	......	.....		.....	7.00	......	8.00	......	8.00
3305	7.03	1.07	8.10	7.00	......	......	3.76	4.29	.....	8.05	7.00	10.05	8.00
3306	0.35	0.41	0.76	0.40	7.30	2.73	1.04	10.03	7.00	11.07	8.00	3.05	2.00
3307	......	.....	....	.....	12.23	4.51	0.68	16.74	15.00	17.42	17.00	.....	......
3308	.....	.....	...	...	.....	......	.....	.....	......	......	.....	53.60	50.00
3309	15.84	.....	15.84	15.00	....	.....	......	......	......	.....	......	......	....
3317	0.70	2.32	3.02	3.29	4.43	1.55	3.14	5.98	8.00	9.12	10.00	8.55	8.00
3318	0.52	1.32	1.87	1.65	5.55	1.71	1.51	7.26	8.00	8.77	10.00	2.47	2.00
3319	0.52	1.24	1.76	1.65	6.16	1.71	1.64	7.87	9.00	9.51	10.00	4.16	4.00
3320	0.71	1.92	2.63	2.47	4.26	1.20	2.70	5 46	8.00	8.16	10.00	6.23	6.00
3310	.86	1.46	2.32	2.46	7.85	1.34	0.94	9.19	9.00	10.13	10.00	4.55	4.00
3311	0.73	0.94	1.67	1.64	5.26	2.76	1.79	8.02	8 00	9.81	9.00	3.20	3.00
3312	0.34	0.50	0.84	0.81	5.22	1.76	1.32	6.98	7.00	8.30	8.00	1.18	1.00
3313	0.54	1.08	1.62	1.64	7.11	1.65	1.02	8.76	9.00	9.78	10.00	2.14	2.00
3314	......	......	2.87	2.46					5.00	22.86	23.00	....	.....
3315	0.56	0.96	1.52	1.64	4.55	2.34	1.40	6.89	7.00	8.29	8.00	4.24	4.00
3316	1.31	1.16	2.47	2.46	5.66	2.49	1.71	8.15	8.00	9.86	9.00	6.35	6.00

THE CHIEF PROVISIONS OF THE FERTILIZER LAW APPLYING TO MANUFACTURERS, IMPORTERS AND DEALERS.

The law for the regulation of the sale and analyses of commercial fertilizers makes the following requirements upon manufacturers, importers or dealers who propose to sell or offer for sale commercial fertilizers in the State:

1. *The Brand.* Each package shall bear, conspicuously printed, the following statements:

The number of net pounds contained in each package.
The name or trade mark under which it is sold.
The name of the manufacturer or shipper.
The place of manufacture.
The place of business of manufacturer or shipper.
The percentage of nitrogen or its equivalent in ammonia.
The percentage of potash soluble in water.
The percentage of phosphoric acid in available form.
The percentage of total phosphoric acid.

2. *The Certificate.* There shall be filed annually between Nov. 15 and Dec. 15 with the Director of the Station a certificate containing an accurate statement of the brand. This certificate applies to the next succeeding calendar year. (Blanks for this purpose will be furnished on application to the Station.)

3. *Manufacturers' samples.* There shall be deposited annually, unless excused by the Director under certain conditions, a sample of fertilizer, with an accompanying affidavit that this sample "corresponds within reasonable limits to the fertilizer which it represents."

4. *Analysis fee.* For each brand of fertilizer sold or offered for sale in the State there shall be paid annually to the Treasurer of State "an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer."

5. *The license.* Upon receipt of the fee, the certificate and the sample (if required), the Director of the Station "shall issue a certificate of compliance."

[The full text of the law will be sent to those asking for it.]

CHAS. D. WOODS, *Director.*

FEEDING STUFF INSPECTION.

CHAS. D. WOODS, Director.

J. M. BARTLETT, Chemist in charge of inspection analyses.

CHIEF REQUIREMENTS OF THE LAW.

The points of the law of most interest both to the dealer and consumer concisely stated, follow.

Kinds of Feed Exempt Under the Law. The law applies to all feeding stuffs *except* the following: hays and straws; whole seeds, meals, brans and middlings of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, sold separately; wheat bran and middlings mixed together and pure grains ground together.

Kinds of Feed Coming within the Law. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, dried distiller's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, corn bran, ground beef or fish scraps, condimental foods, poultry foods, stock foods, patented, proprietary and trade mark stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together or pure grains ground together, and all other materials of similar nature.

The Brand. Each package of feeding stuffs coming within the law shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of crude protein.

The percentage of crude fat.

The Adulteration of Feeding Stuffs. If any foreign substances are added to whole or ground grain or wheat offals, the true mixture must be plainly marked upon the packages.

Duties of the Director. The Director shall in person or by deputy analyze at least one sample of each feeding stuff coming within the requirements of the law, and publish the results with such additional information as circumstances advise. He shall report all violations of the law to the Commissioner of Agriculture.

Penalties. The sale or offering for sale of feeding stuffs not properly branded, or containing a smaller percentage of protein and fat than are guaranteed, or of adulterated feeding stuffs, is punishable by a fine not exceeding 100 dollars for the first, and $200 for each subsequent offense.

The Results of the Inspection for 1903-4.

The last bulletin on feeding stuff inspection was published in May, 1903. Since that time 668 samples have been analyzed by the Station chemists. About 175 of these samples were sent to the Station by correspondents. The others were collected by the inspectors and are from every county in the State. Most of the samples came from the parts of the State where concentrated feeds are most largely used. The samples received from correspondents are marked with * against the sample number in the table which follows. This table contains the results of the analyses of nearly all of the samples collected. In a few cases the samples received from correspondents are omitted, as nothing was known about them. For reasons explained in the discussion beyond the table, fat was usually determined in only one sample of each brand. The results of the analyses are given in the table which follows, and the results are discussed on page 51 beyond the table.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Canary Brand Prime Cotton Seed Meal .... R. W. Biggs & Co., Memphis, Tenn.....	44.44	43.00	–	9.00	9950*
	43.56	43.00	–	9.00	9952*
	43.56	43.00	–	9.00	9953*
	42.69	43.00	–	9.00	9990*
	45.19	43.00	–	9.00	10025*
	46.31	43.00	–	9.00	10047*
	44.38	43.00	–	9.00	10080*
	43.25	43.00	8.65	9.00	10098
	46.38	43.00	8.73	9.00	10099
	44.81	43.00	–	9.00	10157
	48.13	43.00	8.88	9.00	10166
	44.56	43.00	–	9.00	10190
	45.13	43.00	–	9.00	10219
	43.88	43.00	10.15	9.00	10224
	41.38	43.00	–	9.00	10251
	43.63	43.00	–	9.00	10327
	45.50	43.00	–	9.00	10421
	44.12	43.00	–	9.00	10567
	41.00	43.00	–	9.00	10587
	47.50	43.00	–	9.00	10609
Decker Cotton Seed Meal .... Sledge and Wells, Memphis, Tenn......	44.62	43.00	9.88	9.00	10552
Dixie Brand Prime Cotton Seed Meal .... Humphreys, Goodwin & Co., Memphis, Tenn	43.65	43.00	–	9.00	9964*
	40.00	43.00	10.74	9.00	9992*
	37.90	43.00	–	9.00	9995*
	41.63	43.00	–	9.00	10084*
	47.06	43.00	9.83	9.00	10106
	43.56	43.00	–	9.00	10107
	44.81	43.00	–	9.00	10135
	46.25	43.00	–	9.00	10159
	45.06	43.00	–	9.00	10177
	44.63	43.00	–	9.00	10187
	45.88	43.00	–	9.00	10264
	46.69	43.00	–	9.00	10287
	45.00	43.00	–	9.00	10289
	43.06	43.00	–	9.00	10293
	42.13	43.00	–	9.00	10311
	46.19	43.00	–	9.60	10315
	41.25	43.00	–	9.00	10317
	45.25	43.00	–	9.00	10378
	43.63	43.00	–	9.00	10383
	46.94	43.00	–	9.00	10413
	44.50	43.00	–	9.00	10474
	45.00	43.00	–	9.00	10480
	45.75	43.00	–	9.00	10487
	42.75	43.00	–	9.00	10509
	46.25	43.00	–	9.00	10555
	46.00	43.00	–	9.00	10557
	46.44	43.00	–	9.00	10590
	42.38	43.00	–	9.00	10596

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Green Diamond Prime Cotton Seed Meal....... Chapin & Co,. Boston, Mass	42.38	43.00	–	9.00	9976*
	45.31	43.00	–	9.00	9982*
	44.75	43.00	–	9.00	9998*
	43.06	43.00	–	9.00	10023*
	40.06	43.00	–	9.00	10081*
	42.81	43.00	–	9.00	10085*
	40.56	43.00	–	9.00	10089*
	46.44	43.00	–	9.00	10100
	43.88	43.00	–	9.00	10144
	47.13	43.00	–	9.00	10152
	40.44	43.00	–	9.00	10165
	43.00	43.00	8.13	9.00	10185
	44.88	43.00	–	9.00	10209
	44.00	43.00	–	9.00	10228
	43.25	43.00	–	9.00	10234
	47.38	43.05	–	9.00	10256
	46.25	43.00	–	9.00	10283
	43.44	43.00	–	9.00	10297
	44.50	43.00	–	9.00	10312
	47.63	43.00	–	9.00	10369
	43.88	43.00	–	9.00	10388
	45.50	43.00	–	9.00	10396
	45.50	43.00	–	9.00	10400
	46.66	43.00	–	9.00	10415
	41.50	43.00	–	9.00	10416
	44.94	43.00	–	9.00	10439
	44.56	43.00	–	9.00	10441
	44.19	43.00	–	9.00	10464
	44.75	43.00	–	9.00	10491
	44.25	43.00	–	9.00	10499
	41.81	43.00	–	9.00	10531
	43.12	43.00	–	9.00	10545
	43.63	43.00	–	9.00	10583
	44.88	43.00	–	9.00	10594
	44.50	43.00	–	9.00	10595
	42.00	43.00	–	9.00	10601
H. and H. Brand Prime Cotton Seed Meal...... Hayley and Hoskins, Memphis. Tenn..	42.50	43.00	–	9.00	10028*
	45.06	43.00	–	9.00	10049*
	46.31	43.00	10.00	9.00	10138
	44.50	43.00	–	9.00	10359
Horseshoe Brand Prime Cotton Seed Meal..... Hugh Pettitt & Co..............	44.56	43.00	–	9.00	9963*
	43.80	43.00	–	9.00	9967*
	46.00	43.00	–	9.00	10220
	44.38	43.00	–	9.00	10395
	44.62	43.00	–	9.00	10489
	45.25	43.00	–	9.00	10564
Indian Brand Prime Cotton Seed Meal .. ... National Cotton Seed Products Co., Memphis, Tenn....	47.38	40.00	–	8.50	10096*
	45.75	40.00	9.28	8.50	10429
	42.63	40.00	–	8.50	10468
	43.00	40.00	–	8.50	10608
Magnolia Brand Prime Cotton Seed Meal ..... Chas. M. Cox & Co., Boston, Mass...........	42.00	43.00	–	9.00	10074*
	42.13	43.00	8.95	9.00	10129
	44.63	43.00	9.98	9.00	10373
	41.00	43.00	–	9.00	10479
	44.13	45.00	–	9.00	10501

*Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Old Gold Brand Prime Cotton Seed Meal.......	45.00	43.00	–	9.00	9981*
T. H. Bunch, Little Rock, Ark	44.38	43.00	–	9.00	9985*
	44.13	43.00	9.88	9.00	10348
	45.38	43.00	–	9.00	10428
	43.50	43.00	–	9.00	10568
	41.75	43.00	–	9.00	10571
	43.00	43.00	–	9.00	10589
Owl Brand Prime Cotton Seed Meal	41.19	43.00	–	9.00	10063*
F. W. Brodé & Co., Memphis, Tenn	43.38	43.00	–	9.00	10071
	43.00	43.00	8.50	9.00	10158
	39.50	43.00	–	9.00	10203
	41.00	43.00	–	9.00	10233
	44.94	43.00	–	9.00	10265
	40.13	43.00	–	9.00	10294
	41.69	43.60	–	9.00	10314
	46.25	43.00	–	9.00	10375
	38.75	43.00	–	9.00	10380
	42 69	43.00	–	9.00	10427
	44.88	43.00	–	9.00	10579
	43.81	43.00	–	9.00	10592
	41.69	43.00	–	9.00	10607
Phoenix Prime Cotton Seed Meal	46.06	43.00	10.13	9.00	10126
D. L. Marshall, Agent	43.19	43.00	–	9.00	10329
	43.50	43.00	–	9.00	10526
Prime Cotton Seed Meal	43.75	43.00	–	9.00	9975*
American Cotton Oil Co....	41.50	43.00	–	9.00	10087*
	43.13	43.00	9.90	9.00	10130
	47.94	43.00	–	9.00	10142
	40.06	43.00	–	9.00	10151
	47.75	43.00	–	9.00	10361
	46.38	43.00	–	9.00	10397
	41.31	43.00	–	9.00	10451
	42.13	43.00	–	9.00	10453
	42.38	43.00	–	9.00	10465
	44.75	43.00	–	9.00	10484
	43.25	43.00	–	9.00	10527
Prime Cotton Seed Meal	47.25	43.00	7.60	9.00	10226
H. E. Bridges & Co	45.88	43.00	–	9.00	10227
	45.88	43.00	–	9.00	10229
	45.25	43.00	–	9.00	10282
	45.38	43.00	–	9.00	10391
	44.50	43.00	9.90	9.00	10409
	43.13	43.00	–	9.00	10430
	44.50	43 00	–	9.00	10432
	49.12	43.00	–	9.00	10485
	49.37	43.00	–	9.00	10494
	44.13	43.00	–	9.00	10498
	45.00	43.00	–	9.00	10534
	43.88	43.00	–	9.00	10535

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Prime Cotton Seed Meal. Hunter Bros. Milling Company	44.44	43.00	–	9.00	10019*
	44.75	43.00	–	9.00	10073*
	43.63	43.00	–	9.00	10083*
	38.69	43.00	–	9.00	10091*
	44.06	43.00	–	9.00	10092*
	39.88	43.00	8.05	9.00	10119
	41.44	43.00	–	9.00	10120
	44.00	43.00	–	9.00	10149
	39.88	43.00	–	9.00	10155
	42.63	43.00	–	9.00	10168
	47.25	43.00	–	9.00	10204
	44.00	43.00	–	9.00	10231
	44.00	43.00	10.03	9.00	10238
	46.75	43.00	–	9.00	10252
	45.44	43.00	–	9.00	10260
	45.25	43.00	–	9.00	10274
	42.81	43.00	–	9.00	10276
	41.50	43.00	–	9.00	10278
	45.69	43.00	–	9.00	10279
	42.00	43.00	–	9.00	10310
	39.50	43.00	–	9.00	10318
	46.13	43.00	–	9.00	10338
	46.63	43.00	–	9.00	10351
	43.25	43.00	–	9.00	10381
	45.13	43.00	–	9.00	10424
	47.00	43.00	–	9.00	10438
	47.50	43.00	–	9.00	10471
	43.75	43.00	–	9.00	10478
	43.75	43.00	–	9.00	10486
	43.12	43.00	–	9.00	10502
	43.75	43.00	–	9.00	10511
	43.00	43.00	–	9.00	10515
	41.25	43.00	–	9.00	10519
	41.38	43.00	–	9.00	10520
	41.75	43.00	–	9.00	10525
	45.63	43.00	–	9.00	10530
	46.38	43.00	–	9.00	10532
	44.75	43.00	–	9.00	10540
	42.06	43.00	–	9.00	10544
	41.00	43.00	–	9.00	10576
	41.13	43.00	–	9.00	10585
	41.06	43.00	–	9.00	10593
	43.00	43.00	–	9.00	10597
Prime Cotton Seed Meal. Jacksonville Oil Mill Co	41.13	43.00	13.40	9.00	10086*
Prime Cotton Seed Meal. McKellar Bros	45.69	43.00	8.35	9.00	10127
	43.88	43.00	–	9.00	10247
Prime Cotton Seed Meal. Planter's Cotton Oil Co.	42.87	41.00	9.08	–	10569
Prime Cotton Seed Meal. Paris Flouring Co., Agents, Portland	46.88	43.00	9.68	9.00	10215
Prime Cotton Seed Meal. J. E. Soper & Co., Boston Mass	44.75	43.00	9.43	9.00	10205
	43.38	43.00	–	9.00	10277
	46.00	43.00	–	9.00	10350
	44.00	43.00	–	9.00	10500

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Prime Cotton Seed Meal. Southern Cotton Oil Co., Memphis, Tenn.	41.81	42.00	–	7.50	10056*
	39.81	42.00	–	7.50	10059*
	40.63	41.00	10.05	7.50	10225
Soil Brand Cotton Seed Meal. F. W. Brodé & Co, Memphis, Tenn	42.31	†	–	–	10040*
	39.13	†	–	–	10075*
Southern Beauty Brand Prime Cotton Seed Meal. J. G. Falls and Co., Memphis, Tenn	43.50	43.00	8.75	9.00	10334
Star Brand Prime Cotton Seed Meal. Sledge & Wells, Memphis, Tenn	44.94	43.00	–	9.00	9946*
	41.50	43.00	–	9.00	9955*
	44.44	43.00	–	9.00	9956*
	44.44	43.00	–	9.00	9989*
	35.94	43.00	–	9.00	9999*
	34.75	43.00	–	9.00	10000*
	43.00	43.00	–	9.00	10001*
	34.25	43.00	–	9.00	10003*
	39.88	43.00	–	9.00	10006*
	45.19	43.00	–	9.00	10007*
	39.00	43.00	–	9.00	10008*
	36.94	43.00	–	9.00	10009*
	35.44	43.00	–	9.00	10010*
	35.19	43.00	–	9.00	10011*
	36.00	43.00	–	9.00	10012*
	39.13	43.00	–	9.00	10013*
	45.38	43.00	–	9.00	10014*
	40.38	43.00	–	9.00	10015*
	43.50	43.00	–	9.00	10020*
	38.00	43.00	–	9.00	10021*
	36.63	43.00	–	9.00	10022*
	41.31	43.00	–	9.00	10024*
	44.38	43.00	–	9.00	10026*
	42.88	43.00	–	9.00	10030*
	41.50	43.00	–	9.00	10031*
	41.13	43.00	–	9.00	10035*
	42.75	43.00	–	9.00	10055*
	43.38	43.00	–	9.00	10068*
	45.19	43.00	–	9.00	10069*
	37.63	43.00	–	9.00	10076*
	37.69	43.00	–	9.00	10078*
	40.31	43.00	9.78	9.00	10123
	39.00	43.00	11.65	9.00	10167
	41.50	43.00	–	9.00	10172
	43.38	43.00	7.50	9.00	10221
	43.63	43.00	–	9.00	10236
	37 63	43.00	–	9.00	10237
	38.88	43.00	–	9.00	10249
	44.00	43.00	–	9.00	10258
	45.63	43.00	–	9.00	10271
	46.50	43.00	–	9.00	10313
	39.06	43.00	–	9.00	10316
	39.88	43.00	–	9.00	10319
	45.38	43.00	–	9.00	10341
	42.00	43.00	–	9.00	10343
	42.13	43.00	–	9.00	10347
	40.75	43.00	–	9.00	10353
	46.13	43.00	–	9.00	10364
	38.34	43.00	–	9.00	10450
	45.63	43.00	–	9.00	10458
	44.13	43.00	–	9.00	10481
	39.13	43.00	–	9.00	10497
	38.06	43.00	–	9.00	10513
	38.69	43.00	–	9.00	10518
	44.62	43.00	–	9.00	10541
	45.88	43.00	–	9.00	10548
	46.25	43.00	–	9.00	10606

* Sample received from correspondent. † Nitrogen 7½ per cent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Sunflower Brand Prime Cotton Seed Meal ..... J. G. Falls & Co., Memphis, Tenn..	43.80	43.00	–	9.00	9966*
	42.00	43.00	–	9.00	10275
	44 63	43.00	9.58	9.00	10404
	44.25	43.00	–	9.00	10496
	44.50	43.00	–	9.00	10528
	45.38	43.00	–	9.00	10563
Blatchford's Sugar and Flaxseed Meal . ... J. W. Barwell, Waukegan, Ill	26.75	28.00	10.10	11.25	10323
	25.86	28.00	–	11.25	10324
	27.50	28.00	–	11.25	10542
Linseed Meal New Process. .... American Linseed Co	36.38	37.50	3.55	1.00	10108
	37.69	37.50	–	1.00	10148
	35.50	37.50	–	1.00	10194
	35.88	37.50	–	1.00	10208
	37.13	37.50	–	1.00	10222
	35.88	37.50	–	1.00	10239
	35.00	37.50	–	1.00	10246
	31.00	†37.50	7.88	1.00	10253
	35.88	37.50	–	1.00	10281
	36.00	38.00	–	1.00	10288
	31.50	†37.50	7.10	1.00	10295
	32.25	†37.50	–	1.00	10335
	36.06	37.50	–	1.00	10431
	35.06	37.50	–	1.00	10449
	31.38	†37.50	–	1.00	10460
	32.88	†37.50	–	1.00	10463
	31.00	†37.50	–	1.00	10475
	37.13	37.50	–	1.00	10482
	32.00	†37.50	–	1.00	16510
	31.37	37.50	–	1.00	10524
	32.13	†37.50	–	1.00	10529
	32.25	†37.50	–	1.00	10538
	35.87	37.50	–	1.00	10546
	35.50	37.50	–	1.00	10584
	36.38	37.50	–	1.00	10605
Old Process Linseed Meal .... Midland Linseed Co	34.88	32.00	8.01	5.50	10101
	28.81	31.50	–	5.50	10174
	27.63	31.00	–	5.50	10183
	34.56	32.00	–	5.50	10212
Old Process Oil Meal.. .... Metzger Seed and Oil Co	29 25	32.00	7.78	5.00	10175
	34.44	32.00	–	5.00	10273
	34.25	32.00	–	5.00	10298
	29.50	32.00	–	5.00	10308
	31.38	32.00	–	5.00	10352
	29.63	32.00	–	5.00	10472
	29.38	32.00	–	5.00	10547
Old Process Oil Meal . ... American Linseed Co	33.88	32.00	–	5.00	10186
	32.63	32.00	7.25	5.00	10325
	31.38	32.00	–	5.00	10386
Old Process Linseed Oil Meal .... Flint Mill Co............	35.38	36.00	8.00	7.00	10440
Old Process Linseed Meal .... Simmons Milling Co., Red Wing, Minn ...	34.88	†34.00*	7.05	‡7.00	10094*
	33.94	†34.00	–	‡7.00	10591

* Sample received from correspondent.
† These probably are old process meals and should have carried the guarantee of 32 per cent protein and 5 per cent fat.
‡ Guarantee made by Maine dealer from this analysis.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Cream Gluten Meal. Chas. Pope Glucose Co., Chicago, Ill	34.25	34.12	.98	3.20	10266
	38.13	34.12	–	3.20	10299
	41.63	34.12	2.55	3.20	10399
King Gluten Meal. National Starch Co., Chicago, Ill	32.25	35.50	2.13	3.70	10199
	34.88	35.50	–	3.70	10401
Buffalo Gluten Feed. Glucose Sugar Refining Co., Chicago, Ill.	24.75	28.00	2.93	3.00	10102
	23.75	28.00	–	3.00	10109
	23.13	28.00	–	3.00	10136
	21.06	28.00	–	3.00	10145
	24.00	28.00	–	3.00	10156
	21.50	28.00	–	3.00	10162
	24.00	28.00	–	3.00	10176
	25.13	28.00	–	3.00	10188
	23.94	28.00	–	3.00	10192
	22.44	28.00	–	3.00	10210
	23.63	28.00	–	3.00	10240
	23.63	28.00	–	3.00	10250
	24.38	28.00	–	3.00	10263
	21.63	28.00	–	3.00	10291
	22.13	28.00	–	3.00	10292
	23.63	28.00	–	3.00	10309
	23.75	28.00	–	3.00	10320
	21.06	28.00	–	3.00	10336
	24.25	28.00	–	3.00	10344
	24.38	28.00	–	3.00	10358
	22.81	28.00	–	3.00	10370
	26.00	28.00	–	3.00	10384
	23.25	28.00	–	3.00	10390
	25.44	28.00	–	3.00	10408
	25.13	28.00	–	3.00	10435
	24.75	28.00	–	3.00	10448
	23.00	28.00	–	3.00	10452
	24.12	28.00	–	3.00	10522
	24.13	28.00	–	3.00	10549
	23.88	28.00	–	3.00	10570
	22.25	28.00	–	3.00	10581
	25.25	28.00	–	3.00	10612
Crescent Gluten Feed. Illinois Sugar Refining Co., Chicago, Ill.	26.81	28.00	3.48	3.00	10147
	26.69	28.00	–	3.00	10182
	23.75	28.00	–	3.00	10580
Flint Gluten Feed. Flint Mill Co., Milwaukee, Wis	22.00	28.50	3.25	3.00	10284
	22.00	28.50	–	3.00	10414
	22.88	28.50	–	3.00	10461
Manhattan Gluten Feed. Peoria, Illinois	36.69	34.00	–	12.00	10037*
	34.19	34.00	–	12.00	10412
Pekin Brand Gluten Feed. Illinois Sugar Refining Co., Chicago, Ill	22.38	28.00	2.10	3.00	10124
	24.25	28.00	–	3.00	10235
	28.25	28.00	–	3.00	10300
	26.88	28.00	–	3.00	10326
	27.38	28.00	–	3.00	10330
	25.25	28.00	–	3.00	10339
	24.13	28.00	–	3.00	10360
	26.00	28.00	–	3.00	10374
	25.38	28.00	–	3.00	10417
	27.00	28.00	–	3.00	10447
	23.75	28.00	–	3.00	10477
	26.13	28.00	–	3.00	10483
	26.13	28.00	–	3.00	10493
	24.75	28.00	–	3.00	10553
	26.25	28.00	–	3.00	10556
	26.25	28.00	–	3.00	10611

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Warner's Gluten Feed ... Warner Sugar Refining Co., Chicago, Ill.	18.75	28.00	2.43	3.50	10017*
Queen Gluten Feed ...	25.75	27.10	2.43	3.20	10173
National Starch Co., Chicago, Ill ...	24.88	27.10	1.50	3.20	10357
	24.69	27.10	–	3.20	10420
Ajax Flakes ...	29.63	34.00	14.48	12.00	10050*
Chapin & Co., Boston ...	34.81	34.00	–	12.00	10065*
	34.44	34.00	13.90	12.00	10134
	36.31	34.00	–	12 00	10153
	31.63	34.00	–	12.00	10255
	28.50	34.00	–	12.00	10301
	31.88	34.00	–	12.00	10354
	33.25	34 00	–	12.00	10398
	32.00	34.00	–	12.00	10610
Biles Fourex ...	28.44	33.00	–	11.00	10067*
J. W. Biles Co., Cincinnati ...	28.81	33.00	9.45	11.00	10103
	25.56	33.00	–	11.00	10110
	33.06	33.00	–	11.00	10140
	36.44	33.00	–	11.00	10154
	30.38	33.00	–	11.00	10161
	33.38	33.00	–	11.00	10197
	34.13	33.00	–	11.00	10213
	33.75	33.00	–	11.00	10242
	26.75	33.00	–	11.00	10259
	29.25	33.00	–	11.00	10270
	27.25	33.00	–	11.00	10272
	30.50	33.00	–	11.00	10285
	30.13	33.00	–	11.00	10304
	31.25	33.00	–	11.00	10306
	30.00	33.00	–	11.00	10340
	30.75	33.00	–	11.00	10366
	33.38	33.00	9.38	11.00	10372
	30.00	38.00	–	11.00	10385
	28.38	33.00	–	11.00	10394
	27.88	33.00	–	11.00	10402
	32.75	33.00	–	11.00	10411
	32.88	33.00	–	11.00	10436
	31.25	33.00	–	11.00	10462
	28.75	33.00	–	11.00	10512
	32.25	33.00	–	11.00	10514
	30.25	33.00	–	11.00	10516
	30.00	33.00	–	11.00	10517
	32.00	33.00	–	11.00	10523
	27.50	33.00	–	11.00	10533
	29.87	33.00	–	11.00	10562
	26.50	33.00	–	11.00	10573
	31.00	33 00	–	11.00	10582
	31.19	33.00	–	11.00	10600
Union Grains—Biles Ready Ration ...	24.19	24.00	7.13	7.00	10058*
J. W. Biles Co., Cincinnati ...	23.63	24.00	–	7.00	10245
	24.38	24.00	–	7.00	10346
	25.14	24.00	–	7.00	10561
	24.50	24.00	–	7.00	10574

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Blatchford's Calf Meal.. J. W. Barwell, Waukegan..	26.44	26.00	5.25	5.00	10112
	26.00	26.00	–	5.00	10160
	23.56	26.00	–	5.00	10198
	24.88	26.00	–	5.00	10248
	24.38	26.00	–	5.00	10333
	24.63	26.00	–	5.00	10537
	24.75	26.00	–	5.00	10539
	23.87	26.00	–	5.00	10550
Molasses Feed. E. P. Mueller, Milwaukee	21.94	21.81†	–	–	10042*
	16.63	21.81†	3.43	–	10043*
	20.25	21.81†	–	–	10053*
	21.44	21.81†	–	–	10054*
	23.19	21.81‡	3.48	–	10105
	18.75	21.81†	–	–	10305
	18.13	21.81†	–	–	10403
	17.19	21.81†	–	–	10476
Bowker's Animal Meal. Bowker Co., Boston.	34.94	30.00	8.60	5.00	10111
	35.94	30.00	–	5.00	10139
	35.00	30.00	–	5.00	10216
	35.50	30.00	–	5.00	10218
	33.88	30.00	–	5.00	10223
	33.50	30.00	–	5.00	10307
	53.75	30.00	–	5.00	10321
	32.75	30.00	–	5.00	10349
	34.25	30.00	–	5.00	10425
	35.12	30.00	–	5.00	10488
	43.37	30.00	–	5.00	10536
	34.25	30.00	–	5.00	10602
Bowker's Ground Beef Scrap Bowker Co., Boston, Mass	50.00	30.00	14.58	20.00	10131
	51.00	30.00	–	20.00	10426
	49.00	30.00	–	20.00	10442
	44.56	30.00	–	20.00	10459
Bradley's Superior Meat Meal... American Agricultural Chemical Co	34.00	40.00	9.28	8.00	10202
	33.31	40.00	–	8.00	10261
	35.00	40.00	–	8.00	10286
	33.38	40.00	–	8.00	10406
	28.13	40.00	–	8.00	10454
	34.62	40.00	–	8.00	10551
Breck's Animal Meal. J. Breck & Co., Boston	29.50	33.00	10.50	12.00	10422
Breck's Ground Beef Scrap J. Breck & Co., Boston..	42.13	50.00	18.98	15.00	10423
	46.00	50.00	–	15.00	10456
	49.88	50.00	–	15.00	10554
Breck's Poultry and Swine Meal J. Breck & Co., Boston	31.00	32.00	10.60	10.00	10457
Brookside Farm Bone and Meat Scrap S. H. Nash, Bangor..	43.00	39.10	31.05	35.70	10303
	40.50	39.10	29.55	35.70	10405
Ground Beef Scrap. Kendall & Whitney, Portland	70.19	50.00	10.35	9.00	10113
	49.00	50.00	–	9.00	10207
Haskell's Animal Meal George B. Haskell	34.75	30.00	–	5.00	10367

* Sample received from correspondent.
† Protein and fat 21.81 per cent. ‡ Protein and fat 23.00 per cent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Haskell's Ground Beef Scrap. George B. Haskell Co	44.13	30.00	13.67	20.00	10365
Peerless Beef Scrap. Swift's Lowell Fertilizer Co., Boston, Mass	51.00	30.00	16.68	15.00	10280
	45.88	30.00	–	15.00	10379
	50.75	30.00	–	15.00	10407
	41.69	30.00	–	15.00	10455
Swift's Lowell Bone and Meat Meal. Swift's Lowell Fertilizer Co., Boston, Mass	50.00	40.00	9.70	8.00	10133
	33.94	40.00	–	8.00	10141
	46.63	40.00	–	8.00	10163
	35.38	40.00	–	8.00	10193
	35.69	40.00	–	8.00	10211
	30.38	40.00	–	8.00	10419
	34.50	40.00	–	8.00	10444
	37.50	40.00	–	8.00	10490
	34.69	40.00	–	8.00	10599
Swift's Lowell Ground Beef Scrap. Swift's Lowell Fertilizer Co., Boston, Mass	39.00	40.00	22.60	15.00	10443
	44.88	40.00	–	15.00	10598
Akron Oat Feed. Akron Cereal Co., Akron, Ohio	9.75	9.20	2.60	4.14	10363
American Poultry Food. American Cereal Co., Chicago, Ill.	14.38	14.00	6.93	4.50	10217
Apex Stock Food. Chapin & Co., Boston	14.88	16.00	5.93	4.70	10492
Blue Grass Mixed Feed. A. Waller and Co	12.25	12.50	3.10	3.00	10376
	9.50	12.50	–	3.00	10382
Boss Corn and Oat Feed. Great Western Cereal Co.	8.63	9.00	5.05	4.00	10118
	8.25	9.00	–	4.00	10296
	8.63	8.50	–	4.00	10337
	8.13	8.50	–	4.00	10345
Buckeye Wheat Feed. American Cereal Co.	15.50	17.75	4.10	4.70	10434
Canadian Oat Feed. C. M. Cox Co., Boston, Mass.	6.00	7.00	3.70	2.00	10566
Dairy Feed. Great Western Cereal Co.	12.75	12.25	3.10	3.20	10268
	8.25	12.25	–	3.20	10418
De-Fi Corn and Oat Feed. E. Ellsworth Co., Buffalo, N. Y	9.44	8.00	3.10	3.00	10117
	11.63	8.00	–	3.00	10368
Excelsior Corn and Oat Feed. Great Western Cereal Co.	8.63	8.00	4.68	4.00	10121
	9.00	9.00	–	4.00	10189
	11.00	8.21	–	4.58	10371
	8.50	9.00	–	4.20	10470
	8.88	9.00	–	4.20	10503
Haskell's Oat Feed. W. H. Haskell & Co.	14.13	12.00	–	6.25	10005*
	8.63	10.00	5.53	6.25	10262
	8.63	10.00	–	6.25	10521

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Haskell's Stock Food . W. H. Haskell & Co .	8.38	10.00	5.58	2.50	10180
	8.38	10.00	–	2.50	10195
	8.06	10.00	–	2.50	10214
	8.00	10.00	–	2.50	10332
	8.31	10.00	–	2.50	10613
Henkell's Oats and Corn Chop Feed. Commercial Milling Co	8.81	10.81	6.03	6.02	10143
	8.31	10.81	–	6.02	10505
	8.88	10.81	–	6.02	10508
Hominy Feed Chas. M. Cox & Co., Agents	10.00	10.50	8.48	7.50	10257
Hominy Feed Husted Milling Co.	10.00	–	7.43	–	10565
Hominy Feed Hunter Bros .	10.69	11.00	8.55	7.70	10191
H-O Poultry Food . H-O Co., Buffalo, N. Y.	17.06	17.00	5.81	5.50	10137
	17.25	17.00	–	5.50	10355
Merritt's Jersey Cow Feed . E. Merritt & Sons, Houlton	29.13	28.00	6.65	6.00	10095*
Mixed Feed .. Great Western Cereal Co.	9.00	10.30	4.03	6.00	10290
Oat Feed . C. M. Cox Co., Agents.	5.88	–	2.92	–	10132
Puritan Chick Food .	12.63	–	7.52	–	9980*
Quaker Dairy Feed . American Cereal Co., Chicago, Ill .	9.00	12.00	–	2.00	10004*
	13.38	14.00	4.25	3.50	10201
	13.38	14.00	–	3.50	10356
	13.25	14.00	–	3.50	10575
Quaker Oat Feed American Cereal Co., Chicago, Ill	12.56	14.00	3.57	3.50	10171
	11.38	14.00	–	3.50	10267
	14.00	14.00	–	3.50	10393
Royal Oat Feed Great Western Cereal Co.	5.63	6.00	2.50	2.00	10116
	5.44	7.50	–	2.60	10150
	2.88	7.50	–	2.65	10196
	5.94	7.50	–	2.65	10392
Victor Corn and Oat Feed American Cereal Co., Chicago, Ill .	8.81	9.00	4.03	4.00	10125
	7.94	9.00	–	4.00	10146
	8.50	9.00	–	4.00	10170
	8.00	9.00	–	4.00	10181
	8.75	9.00	–	4.00	10200
	8.88	9.00	–	4.00	10243
	8.63	9.00	–	4.00	10302
	8.63	9.00	–	4.00	10328
	8.50	9.00	–	4.00	10342
	8.75	9.00	–	4.00	10433
	8.38	9.00	–	4.00	10445
	8.00	9.00	–	4.00	10559
	8.75	9.00	–	4.00	10572

* Sample received from correspondent.

ANALYSES OF SAMPLES.

Name of Feed and Manufacturer or Shipper.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Vim Oat Feed. American Cereal Co., Chicago, Ill.	6.94	7.50	3.20	2.75	10269
	5.75	7.50	–	2.75	10377
	7.06	7.00	–	2.75	10446
Yankee Corn and Oat Feed. Great Western Cereal Co., Chicago, Ill.	7.88	7.58	2.35	2.00	10331
Clover Meal. Cypher's Incubator Co., Boston, Mass.	13.00	–	3.85	–	10322
Gee's Extra Fancy Sharps. G. E. Gee Company, Minneapolis, Minn.	13.00	13.25	3.90	2.07	10128
	12.81	13.25	2.20	2.07	10362
Gee's Oil Cake Compound. G. E. Gee Co., Minneapolis, Minn.	13.75	15.25	6.18	8.50	10122
Bran. Ansted and Bush Co.	17.31	–	–	–	10045*
Bran. Geo. Tillston Milling Co., St. Cloud, Minn.	14.30	–	–	–	9986*
Bran. D. Smith & Co., St. Louis.	15.56	–	–	–	10469
Pillsbury's Bran.	15.00	–	–	–	10046*
Saginaw Bran.	13.44	–	–	–	10044*
Winter Wheat Bran. Dorr & King, Pittsford, Illinois	13.12	–	–	–	9965*
	15.81	–	–	–	10016*
Blish Mixed Feed. Blish & Company	15.81	–	–	–	10387
Daisy Mixed Feed. Daisy Roller Mills	16.50	–	–	–	9960*
	15.38	–	–	–	9961*
Farmer's Favorite Cow Feed. Valley City Milling Co.	15.19	–	–	–	10389
Mixed Feed. North Western Elevator Mill Co., Toledo, O	17.88	–	–	–	10018*
Pillsbury's Daisy Flour	20.69	–	6.58	–	9959*
Red Dog Flour. Pillsbury—Washburn Co	16.87	–	3.50	–	9969*

* Sample received from correspondent.

Discussion of the Results of Analyses.

With the small appropriation made by this State for the inspection of concentrated commercial feeding stuffs, it is not practicable to collect samples of the feeding stuffs on sale in Maine as frequently as a thorough inspection demands; nor is it possible to make as complete analyses of the samples collected as is desirable. The tables show, however, that a large number of samples have been received. The most valuable constituent of a feeding stuff, from the standpoint of the purchaser, is protein. Fortunately this can be determined at less cost than any other ingredient. For these reasons protein has been determined in every sample collected. Fat is fairly uniform in high grade goods of the same class and on this account its determination is of less importance. It was, therefore, for the most part determined in only one sample of each brand. The determination of woody fiber in many kinds of goods is very important and it is to be regretted that the funds available for this work are too small to admit of its estimation in any of the samples. In case of certain possible adulterations the ash should be determined. This has, however, for the same reason, been impracticable.

COTTONSEED MEAL (ANALYSES PAGES 39-44).

Cottonseed meal is a by-product from the manufacture of cottonseed oil. After the cotton has been taken from the seed in the cotton gin, the remaining down or "linters," and the hard black seed coats or hulls are removed by machinery. What remains of the seed is cooked, and the oil expressed by high pressure. The resulting cottonseed cake is ground into the bright yellow cottonseed meal of commerce. Such a meal carries from 40 to 50 per cent protein.

The shippers of cottonseed meal for the most part guarantee 43 per cent protein and 9 per cent fat. According to the classification of the Cotton Seed Crushers Association, "prime" cottonseed meal from the Gulf States must carry not less than 8 per cent, and that from the South Atlantic States not less than 7½ per cent ammonia. As 8 per cent ammonia is equivalent to only 41.19 per cent protein, it is evident that the minimum guarantee is placed higher by the shippers than the Association calls for in prime meal. Hence a meal that carries 41 per cent protein is

"prime" in the trade sense, but is below the guarantee usually placed upon cottonseed meal sold in Maine.

The hulls and cotton which should be removed from the seed before it is crushed and pressed have but little feeding value. A little of these materials is always present in the meal. The temptation to include as much of them as practicable is great. Occasionally it happens that considerable of the black hulls are ground with the cake and a dark colored meal of inferior feeding value is the result. From information that seems reliable it appears that recently considerable money has been invested in machinery designed to grind the hulls very fine and thus disguise them more completely. This may account for much of the cottonseed meal offered this year in Maine running lower than it has in past years in protein and fat.

Strictly first class fresh cottonseed meal is always bright and yellow and should have a pleasant nutty flavor. Not all dark colored cottonseed meal is necessarily adulterated. Spontaneous heating of the seed in the field, or overcooking of the "meat," may render the meal dark in color without changing its composition. Such meal is not first quality, however, and is usually sold at a lower price. Cottonseed sometimes carries practically no cotton and the hulls break up and pass into the meal. This is, of course, an adulteration with hulls, although an unintentional one.

The hulls are lighter than ground cottonseed cake, and their presence in meal, particularly if they are not finely ground, can be readily detected by stirring up a little of the meal in a tumbler with hot water. The hulls will settle out more slowly and will appear on the top of the meal in the bottom of the tumbler. Testing a high grade meal in comparison with a poor meal will easily familiarize any one with this simple, yet quite reliable test.

Samples have been received of 24 different named brands and quite a number of samples have been forwarded by dealers that were unbranded. These were usually samples that were submitted to them for purchase and in many instances the reported low analyses have resulted in the Maine dealers not buying the goods. This is one way in which the law has greatly helped the dealer and still more, the consumer.*

* This is illustrated by a sample of cottonseed meal offered to the Paris Flouring Company. On analysis is was found to carry only 24.62 per cent protein, and the goods were not purchased.

The samples sent in by correspondents have as a rule run lower in protein than those collected by the inspectors. This is to be expected, for usually the consumer only sends a sample because he suspects it to be of inferior quality. This prompt free analysis of samples from correspondents makes it possible for a feeder to know just what he is using.

From December to June it is fairly easy for the dealers to obtain cottonseed meal of good quality, and on this account those consumers who are so situated that they can do so, will find it avantageous to purchase in the winter all the cottonseed meal they will need until new meal from another crop will be on the market. Even if the price should drop somewhat, this would usually be more than offset by the superior quality of the meal obtained at the time of the early purchase.

With an occasional exception, most of the cottonseed meal analyzed at the Station has come up to the guarantee, or nearly so. The number of samples that have run much above the guarantee have been less than in former years. To the uniform good quality of most of the meal, that sold under the name of "Star brand prime cottonseed meal" has been an exception. Because of the poor appearance of these goods a very large number of samples were sent to the Station by dealers and consumers. Out of 57 samples examined, 31 were received from correspondents. A large number were from the house which imported the goods and were taken from car load lots before they were distributed. The importers state that these good were then sold on their merits as indicated by the Station analyses, and that they were guaranteed for their actual protein content.

Not only was much of Star brand cottonseed meal low in analysis, but it was of poor appearance. Even when it carried the full amount of protein it was usually of poor color and taste. It would seem that the shippers of this brand did not intend to handle good meal. It is said that they have reformed in this particular, and that Star brand goods after this will be of good quality. It is to be hoped that this is the case, but for the present, users of this brand of cottonseed meal should be watchful as to its quality.

Sea Island cottonseed meal, which a few years ago was common in the State, was not found at all this year in the hands of

the dealers. That it still is in other markets and is only kept out because of the feed law, is illustrated by a sample (No. 9977 with 24.75 per cent of protein) that was offered a Maine dealer and by him sent to the Station for analysis.

Cottonseed feed meal has been found in other states, but none has yet come to Maine. A sample was sent to the Oscar Holway Company of Auburn, which they sent to the Station. It analyzed as follows:

Sample No. 10,077, 5.88 per cent water; 4.38 per cent ash; 23.88 per cent protein; 21.57 per cent fiber; 6.82 per cent fat.

When it is remembered that good cottonseed meal carries about 7 per cent of crude fiber, the bad quality of this feed meal is even more apparent than its low protein content indicates.

LINSEED MEAL (ANALYSES PAGE 44).

Linseed meal is made by grinding flax seed from which the oil has been more or less completely removed. "Old process" meal is made from oil cake from which as much as possible of the oil has been removed by pressure. In the "new process" the oil is extracted by the use of naphtha. Old process meal carries more fat and less protein than new process. Because of the method of manufacture, new process meal is somewhat more uniform in composition. Cleveland flax meal is a trade name for a new process linseed meal. Oil meal is quite a common trade name for old process linseed meal.

Most of the oil meal was up to its guarantee in protein. No evidence of any adulteration of this class of feeds was found. Quite a number of samples of American Linseed Oil Company's meal were taken from lots that were apparently wrongly tagged. They should have been labelled old process and guaranteed 32, instead of 37.5 per cent protein. Fat was determined in two of these samples low in protein and they were found to carry much more fat than new process meal would. The samples referred to in the foot note on page 44 were doubtless all from old process meal. Because of the relatively lower price, more linseed meal has been used than for many years.

GLUTEN MEALS AND FEEDS (ANALYSES PAGE 45).

Gluten meals and gluten feeds are by-products left in the manufacture of starch and glucose from Indian corn. Corn consists

largely of starch. The waste product in the manufacture of starch or sugar is relatively much richer in oil and protein than is corn.

Most factories remove part of the corn oil from the waste, so that nearly all the gluten meals carry less oil than they did a few years ago. Gluten feeds differ from gluten meals in that they contain a good deal of the corn bran, and hence relatively less of protein, fat and digestible carbohydrates, and more of the indigestible woody fiber.

Gluten meal, which a few years ago was so largely used, is now practically out of the market. Chicago gluten was temporarily taken out of the market by the burning of the building where it was manufactured. The building has been rebuilt, but it is not certain that the meal will be again put upon the market. Two samples of King gluten meal were found, but it is understood that this brand has been permanently taken out of the market. The samples of this brand agree fairly well with the guaranteed analyses. Three samples of Cream gluten meal varied greatly in composition. The protein content was greater in each case than the guarantee.

The gluten feeds run considerably under the guaranteed percentage of protein. The Flint gluten feed is guaranteed 28.50 per cent, the gluten feeds of the Glucose Sugar Refining Company, the Illinois Sugar Refining Company and the Warner Sugar Refining Company are all guaranteed 28 per cent protein, and the National Starch Company guarantees its gluten feed to carry 27.10 per cent protein. The gluten feed highest in protein carried only 27.38 per cent, and the lowest carried 18.75 per cent protein. A guarantee based upon the samples examined and here reported should not be higher than the following for the brands as named: Buffalo 24 per cent, Crescent 26, Flint 22, Pekin 25, Warners 18, and Queen 24 per cent protein.

The seasons of 1902 and 1903 were unfavorable to corn, and it may be that another season's goods may contain nearer 28 per cent protein. In compounding rations it will, however, probably be safer to discount this guarantee somewhat.

DISTILLERS' GRAINS (ANALYSES PAGE 46).

Dried distillers' grains resemble in composition the gluten feeds. They are, however, much more bulky. They are derived chiefly from corn from which the starch is removed by fermentation. A feeding experiment conducted at this Station* showed these grains to be a valuable source of protein. Two brands, Ajax flakes and Biles Fourex, are on the Maine market. Commission houses have sent a few samples of presumably other kinds, but the analyses have been practically the same as the two named. Neither of the brands run up to the guarantee in protein. On the average Biles Fourex carries not much better than 30 per cent and Ajax flakes about 32 per cent protein. The goods are somewhat difficult to sample accurately and it may be that the extremely low analyses do not fairly represent the goods. The poor quality of the corn of the season of 1903, poorer even than that of 1902, probably explains this falling off, as in the case of the gluten feeds. However that may be, the manufacturers of these various corn wastes should be on the lookout for such changes and make their guarantees accordingly.

UNION GRAINS. (ANALYSES PAGE 46).

Union grains are a ready made mixture carrying the protein and fat according to the guarantee. They are based upon a feeding experiment with Holstein cattle in which Biles Fourex was fed in combination with wheat bran, gluten feed, ground corn, ground oats, and oil meal. For the farmer who must buy all his feeds, Union grains at a fair price would probably prove profitable. As a rule, oats and corn are profitable for cows when the feeds are home grown and expensive feeds to purchase. A feeding test is being made at this Station with Union grains.

BLATCHFORD'S CALF MEAL (ANALYSES PAGE 47).

Blatchfords' calf meal has been upon the market for several years. It is apparently pretty widely distributed in the State. The first sample examined by the Station in 1898 carried 33.44 per cent protein. This sample was probably much higher in protein than the goods usually run. The year following the samples ran about as this year, with 25 per cent protein. The

* Buletin 92, page 65.

guarantee for protein is one per cent higher. In this year's samples the protein ran from 23.56 to 26.44 per cent.

MOLASSES GRAINS (ANALYSES PAGE 47).

Brewers' grains are not sold in the State, but recently a Milwaukee firm has been putting upon the market a mixture of dried brewers' grains and molasses, under the name of Molasses grains, or Molasses feed. The goods are rather sticky and do not run uniform, so far as the 8 samples analyzed show. The guarantee is not in accord with the law of this State, but covers the sum of protein and fat. Deducting the fat found, the guarantee for protein is about 18 per cent and the goods with two exceptions carried more protein. The protein ran from 16.63 to 23.19 per cent. It seems doubtful if this can be sold at a price that will be economical for a horse or a cow feed at this distance from its place of manufacture.

MEAT MEALS AND GROUND SCRAPS (ANALYSES PAGE 47).

The meat meals and ground beef scraps are used chiefly for feeding poultry, and while they are very generally distributed, it is probable that the sales are not large as compared with other materials coming under the feeding stuffs law. The guarantees placed upon the goods are only a very general guide to the actual composition. It will be noted that while all the brands are quite irregular in composition, that some uniformly run much higher in protein than others. Some of the companies have made at least two guesses in different years as to what their goods are and evidently some still need revision. Bradley's superior meat meal is guaranteed 40 per cent and carries from 28 to 35 per cent protein. Kendall & Whitney's ground beef scrap, guaranteed at 50 per cent, carried in one instance 49 per cent and in another 70 per cent. Swift's Lowell bone and meat meal ranged from 30 to 50 per cent protein. As these feeds are used only in small amounts in a ration, the fluctuations do not greatly affect the daily food of the fowl.

REFUSES FROM MILLING OATS, CORN, ETC. (ANALYSES PAGE 48).

The use of the various oat feeds, corn chops, corn and oat feeds and similar offals by themselves, or blended with concentrated feeds, still continues. They vary in composition from the

straight oat hull refuse, with less than 6 per cent protein, to blends that carry from 15 to 18 per cent protein. For the most part these goods are fairly well up to their guarantees. No fault can be found with the manufacturer for desiring to sell these waste products. They make few claims for nutrients which the goods do not actually carry. The feeder has himself to blame if, with barns filled with hay, corn fodder and silage, he buys this class of feeds low in protein, instead of those high in protein. An oat feed with 6 per cent protein is no better feed nor is it any better digested than oat straw with the same protein content. It is finely ground and saves some work of mastication for the animal that eats it.

Clover meal is sold for poultry. In composition it corresponds fairly well with ordinary clover.

Gee's extra fancy sharps and Gee's oil cake meal are made from wheat refuses and the weed seeds removed in cleaning wheat before milling. They are not sold at such prices as to invite their use in preference to the materials they more or less resemble in protein content.

WHEAT BRAN AND MIDDLINGS—MIXED FEED (ANALYSES PAGE 50).

The results of analyses of samples of wheat offals sent to the Station by correspondents and collected by the inspectors are given in the table.

In the fall of 1899 the State was flooded with low grade, adulterated wheat brans and mixed feeds. Because of the publicity given to these fraudulent goods and the co-operation of the best of the large dealers, they have quite largely disappeared, or are sold under a proper guarantee.

There is so much profit in selling ground corn cobs, broom corn and other valueless materials at the price of wheat bran that the consumer must ever be on the watch against this fraud. The safest thing is to buy only well known reliable brands of this class of goods. If consumers will see to it that all of this class of feeds which they buy carries the name of the miller, there will be little likelihood of their being defrauded. In case of any doubt, any resident of Maine is invited to mail a sample to the Station. An analysis will be made and the results reported promptly and without charge.

THE KIND OF CONCENTRATED FEEDING STUFFS TO PURCHASE.

The crops grown upon the farm are rich in carbohydrates and poor in protein. Clover will help supply the needed protein, and home grown grains will help out toward a balanced ration. But after growing all the food that can be produced economically on the farm, the dairyman will usually find that he needs to supplement the home grown food by the purchase of concentrated commercial feeding stuffs.

As the farm produces or can be made to produce all the starch, sugar and fiber that are needed, it is not necessary to take these constituents into account in the purchase of supplementary food materials. While they have a part, and a necessary part, in the ration, it is protein that is needed to supplement the home grown foods, hence the cost per pound of the protein in a given feeding stuff is of more importance than the ton price. A ton of cottonseed meal costs more than a ton of oat feed, but the protein in the former costs less than four cents a pound and ten or more in the other. The following table shows the number of pounds of protein that a ton of a few average feeding stuffs carries, and the cost of a pound of protein at the usual range in selling price.

COST OF ONE POUND PROTEIN IN DIFFERENT FEEDING STUFFS AT DIFFERENT PRICES PER TON.

Kind of feeding stuff.	Protein in ton.	At $18 per ton.	At $20 per ton.	At $24 per ton.	At $26 per ton.	At $28 per ton.	At $30 per ton.
	Pounds.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Cottonseed meal........ ..	840	....	....	....	3.0	3.3	3.6
New process linseed meal..	750	....	....	....	3.4	3.7	4.0
Old process linseed meal...	640	....	....	....	4.1	4.4	4.7
Gluten meal................	680	... ...	....	....	3.8	4.1	4.4
Gluten feed	520	.... ..	....	4.6	5.0	5.4	....
Distillers grains	660	....	....	....	3.9	4.2	4.5
Union grains.........	480	....	....	....	5.4	5.8	6.2
Wheat middlings	360	5.0	5.4	....	... . ..	....	....
Wheat bran	300	6.0	5.7	... .	....	....	....
Oat feed as Vim or Royal ..	150	12.0*	. ...	....	....	... .	... ...

* At $12 per ton, a pound of protein will cost 8 cents.

WEIGHT OF DIFFERENT CONCENTRATED FEEDS.

It is the common practice in Maine to feed by measure rather than by weight, and since different feeding stuffs vary greatly in weight, it is obviously unfair to compare the feeding values of different feeding stuffs measure for measure. For instance, a quart of cottonseed meal weighs one and one-half pounds, and a quart of dried distillers' grains weighs less than half as much. To assist feeders who have no conveniences for weighing, the following table, prepared by Mr. H. G. Manchester, West Winsted, Conn., is reprinted from Bulletin 145 of the Connecticut Agricultural Experiment Station.

THE AVERAGE WEIGHT OF ONE QUART OF EACH OF THE FEEDS NAMED.

	Pounds.
Cottonseed Meal	1.5
Linseed Meal, old process	1.1
Linseed Meal, new process	0.9
Gluten Meal	1.7
Gluten Feed	1.2
Distillers' Grains	0.7
Wheat Bran, coarse	0.5
Wheat Middlings, coarse	0.8
Wheat Middlings, fine	1.1
Mixed Wheat Feed	0.6
Corn Meal	1.5
Hominy Meal	1.3
Oats	1.2
H. O. Dairy Feed	0.7
Victor Corn and Oat Feed	0.7

ENTIRE WHEAT FLOUR.

CHAS. D. WOODS AND L. H. MERRILL.

Of all the food products which a beneficent nature has placed at man's disposal, wheat easily ranks first. It is true that rice forms the staple food for a larger proportion of the human race, yet it needs no argument to prove the superiority of wheat over this cereal. This superiority is due not only to the intrinsic food value of the wheat kernel, but also to the vast number and variety of products which can be derived from it. The requirements of our modern civilization, and the introduction of the methods and machinery that have made the fulfilment of these requirements possible, have led to a close study of the structure of the wheat kernel. No other seed has received a tithe of the attention bestowed upon this, and the introduction at this place of all that botanists are able to tell us of this wonderfully complex little seed would be of little service to the general reader. At the same time, some knowledge of the anatomy of the wheat kernel is so essential to a clear understanding of the facts to be presented in the following pages that a brief space is devoted to the subject. As this bulletin is designed for non-scientific readers, the use of technical terms is avoided as far as possible.

It does not require a very close inspection of the kernel to discover that it consists of three distinct parts: 1. The essential part of the seed which, when the seed is planted and grows, develops into the new plant. This is known as the embryo, or germ, or chit. 2. A much larger portion, making up the greater part of the grain, which is designed by nature to serve as food for the young plant during germination, or the earlier stages of growth; precisely as a piece of seed potato serves as food for the young potato plant, or as material stored in the egg furnishes nutriment for the developing chick. This part of the wheat kernel is known to botanists as the endosperm, and is the only part which enters into our fine white flours. 3. The coverings

of the kernel, the bran, designed to protect the softer inner portions. These three divisions and their relative proportions are conveniently shown below.

1. Germ or embryo, 6 per cent of the wheat kernel.

2. Endosperm or floury part, 82 to 86 per cent of the wheat kernel.

3. Bran or coverings (not including the aleurone layers), 8 to 9 per cent of the wheat kernel.

To these divisions should be added the aleurone layer, making up 3 or 4 per cent of the kernel. Although this layer is botanically a part of the endosperm, it is more convenient, as shown below, to consider it by itself.

Figure 9 shows the divisions named, and also the position of the brush.

Chemical analysis shows that the germ is not only rich in oils and mineral constituents, but contains also a large proportion of nitrogenous matter. Since we have no reason for supposing that these nutrients are any less digestible than those furnished by the endosperm, it may be asked why the germ should not be included in the flour. To this it may be replied that the germ is dark in color and the flour containing it would not make an attractive loaf. Perhaps a better reason for the exclusion of the germ lies in the readiness with which the oils absorb oxygen from the air, thus becoming rancid and imparting a disagreeable flavor to the flour. Since this change comes about slowly, this objection would not extend to flours which are used within a few months after milling.

The endosperm, as has been said, is the only part of the kernel which enters the higher grades of flour. It contains all the starch and all the gluten of the wheat. True gluten is found only in wheat and gives this grain its preeminence over the other cereals. On this account its distribution in the kernel is a matter of importance. The outer part of the endosperm differs radically from the inner parts, consisting of nearly square cells filled with a granular form of protein known as aleurone. However valuable this aleurone may be as a food, it should not be confounded with the gluten, which is found only in the interior of the endosperm. This outer layer of cells is properly known as the aleurone layer, and the name "gluten layer" sometimes given to it is a misnomer. In the processes of the manufacture of fine

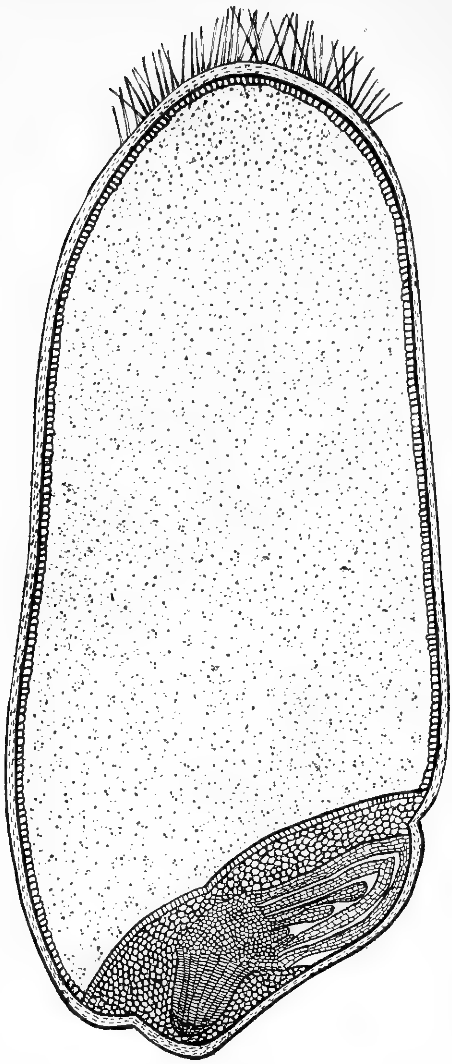


FIGURE 9. Longitudinal section of a grain of wheat. The cut shows the brush of short hairs at the apex, the germ at the base, and the outer coatings or bran, with the cubical cells of the aleurone layer, lying just within. The dotted area, occupying the greater part of the kernel, represents the endosperm or floury portion.

white flour, the aleurone layer is rejected from the flour and is included in the waste products. The middle of the endosperm is softer than the outer parts, being richer in starch and poorer in gluten. If ground by itself, it would make an inferior grade of flour. From the center outward, the proportion of gluten gradually increases, the largest amount being found in that part of the kernel which lies just within the aleurone layer.

The term "bran," as ordinarily employed, includes all the portions of the grain removed in the milling processes. It is here, however, used with a restricted meaning, and includes only the wheat coverings lying outside the aleurone layer, and does not include the germ. The different parts of the bran vary greatly in composition and this has led to a close study of the coverings of the wheat berry, the general results of which follow.

The seeds of all our common agricultural plants are borne within a cavity called the ovary. As the seed matures, the ovary usually opens and the seed is discharged. In the grass family, to which the cereals belong, we find an exception to this rule. Here the ovary does not open to release the ripened seed, but becomes so closely adherent to the seed that a sharp separation is impossible. Perhaps this may be made clearer if we suppose a common garden bean (seed) growing until it entirely fills the pod (ovary), to which it finally becomes so closely cemented that the bean cannot be shelled.

The wheat kernel, then, consists of a seed still enclosed within the ovary walls. This fact will help to explain the complexity of the wheat coverings, or bran, as the word is here used. The ovary walls constitute what is known to the botanist as the pericarp. In the immature kernel this is found to consist of three distinct layers, the outer of which, the epidermis, bears the small tuft of hairs sometimes called the brush. Within the pericarp are the true seed coatings, consisting also of several layers, the two outer making up the episperm, while the inner is termed the perisperm.

This may be summed up as follows:

Pericarp (walls of the ovary),	Made up of three layers of cells, the outer of which, the epidermis, carries the brush.
True seed coatings	Episperm, of two layers. Perisperm.

While all these divisions may be distinguished in the immature grain, in the ripened and dried kernel the cells composing them collapse and adhere so closely to one another that the minor distinctions become largely obliterated.

Since a close separation of these coatings is impossible, we can not determine with exactness their relative food values. It is generally conceded, however, that both the pericarp and the true seed coatings (episperm and perisperm) consist almost wholly of woody and mineral matter, with but little protein. The nitrogenous matter of the bran of commerce is for the most part contained in the adhering aleurone cells.

The simplest method of milling wheat consists in crushing the berry, thus reducing it more or less completely to a powder. The wheat meal thus prepared will always contain coarse particles of bran. Bread made from this wheat meal will obviously contain all of the nutrients of the original wheat, but the bread will be coarse in texture, dark in color and rather strong in flavor. These objectionable features are much more pronounced in wheat meal made from hard spring wheat than in soft winter wheat meal. Graham flour* or wheat meal is usually made from soft wheats relatively low in protein and high in starch content. Because of this, graham flour, as found in the market, is usually lower in protein than is high grade patent flour. Sifting wheat meal, to remove the coarser particles, was the first step toward the making of white flour. As explained above, the ovary walls and the true seed coats adhere very firmly to the floury part of the wheat berry, and can at best be only imperfectly separated. Up to the middle of the last century even the best milling involved grinding the wheat in a set of stones with cut faces run not quite touching each other, and the fine flour was obtained by sifting by means of bolts, *i. e.,* sieves, of varying fineness. As fine grinding would reduce some of the outer coatings to a fine powder, with a resulting dark flour and still darker loaf, only soft wheats, which would readily crush and reduce the soft starchy interior to flour without powdering the germ and outer layers, were employed in making the first grades of flour. This method of manufacture of fine flour from starchy

*So called from Graham, the temperance reformer of the early part of the nineteenth century, who based his cure for alcoholism upon certain radical changes in diet, laying especial stress upon abstinence from meats, and the use of bread made from unbolted wheat meal.

wheats resulted in flours relatively low in ash and protein and rich in starch and allied carbohydrates. Flour with no more than 8 per cent protein and .3 per cent ash were not uncommon. It was this kind of flour that led Liebig to recommend a return to wheat meal and gave Graham the "physiological basis" of his crusade in favor of bread made from unbolted wheat meal. Despite the agitation of this important question, the use of fine flour did not diminish and the results of investigations indicated, on even the part of the poorer classes, an almost invariable preference for white bread. This was particularly the case in the cities, and was at first attributed to perverted taste and classed along with the desire for alcohol, and other abnormal appetites. Investigations by Lawes and Gilbert* showed that this preference was based upon a real difference in nutritive quality, and that while graham bread actually carried more protein and ash than white bread, it passed through the intestines rapidly "before the system has extracted from it as much nutritive matter as it ought to yield." This increased peristaltic action, resulting in lowered digestibility of the bread, was attributed by Lawes and Gilbert to the mechanical action of the bran upon the lining of the intestine. This seemed a reasonable hypothesis and some rather inefficient attempts were made to manufacture a flour in which the bran should be reduced to the fineness of flour. Before much was accomplished in this direction, the method of milling was revolutionized by the introduction of the Hungarian or continuous reduction process. Up to this time the grain had been ground and the milling products separated by a final sifting. The new process passes the wheat through successive sets of rollers or rolls set nearer and nearer together as the milling proceeds. The flour from each set of rolls is removed by sifting and the unreduced portions are passed on to another set. While modern flour mills differ from each other in details, they are all essentially the same in that the bran is separated from the interior of the grain and this interior is reduced to flour by repeated crushing between rollers and numerous separations by means of bolting machines. The bran is also passed through successive rolls and bolting machines, until it is as thoroughly cleaned from the adhering flour as practicable for the kind of flour to be made, or until the cost of reduction so nearly equals the value of the flour

* Chemistry of Wheat and Flour. Lawes and Gilbert, 1857.

obtained as to be pecuniarily unprofitable. The number of intermediate products will depend upon the size of the mill, the number of stands of rolls and number of bolts to which the grain and resultant meals are subjected. The finished products also vary in different mills, but in general consist of

First patent flour Second patent flour First clear grade flour	In most mills these are united into the "straight" or "standard patent" flour used for bread.
Second clear grade	Used for low grade bread.
Red dog flour	Used for bread or for cattle feed.
Shorts or middlings Bran	Frequently sold together as mixed feed for cattle.

The process from start to finish is under the control of the miller and he can make almost any separation desired. For instance, in the demand for breakfast foods it has been found profitable by some millers to separate the middlings and germ in the granular state and sell them under a variety of names, in bulk or fancy packages, at a price considerably in excess of what they would bring in the usual finished form.

The introduction of the roller process of milling has made it possible to utilize the hard spring wheats rich in gluten, and to include in the "straight" or standard patent bread flour much that in the old process of milling was lost in middlings and bran. This has materially improved the bread flours in common use until the standard flours from hard wheat carry more protein than almost any graham flour in the market 25 years ago, and as much or more than many graham flours now on the market. Furthermore, the demand for bread flour of high gluten content has stimulated wheat breeding and the growing of hard wheat, so that even winter wheats are now grown which in gluten content rival the hard spring wheats of the Northwest.

Just before the introduction of the roller process into milling, the attempt was made to find a way to remove the outer or ovary wall layers of the wheat berry, and to grind the remainder into a meal or flour without bolting. It was hoped in this way to make a flour that would carry essentially all the nutrients of the wheat and which would not contain the indigestible woody fiber of the outer coatings, which Lawes and Gilbert had found not only to be indigestible of themselves, but also to so hasten the passage of the bread containing these woody particles as to materially lessen the whole amount of nutrients digested. It was claimed that such a flour would carry the whole of the wheat that

has value in nutrition, and thus such flour was at first called whole wheat flour, and later, entire wheat flour.

The Germans seem to have done more experimenting with "decorticated wheat flour" than others, but judged both from the intrinsic difficulty of the separation and from the published analyses of the product, their labors seem to have been only partly successful. If it had not been for the introduction of the roller process, possibly machines to decorticate wheat might have been devised. But this new method at once gave so much better results than any method of decortication then known that it speedily was adopted for all kinds of flour milling, even graham flour being thus made at present.

As now made, 100 pounds of cleaned No. 1 wheat will make either nearly 100 pounds of graham flour, 85 to 88 pounds of entire wheat flour, or 72 to 74 pounds of straight or standard patent bread flour. Larger mills will usually give rather larger yields than small mills, and a starchy wheat 1 to 3 pounds more entire wheat or patent flour than a hard wheat. In the following diagram, cleaned wheat is taken as the standard. Before milling it is customary to clean the wheat from foul seeds and to remove as much as possible of the dirt from the crease in the berry. In this operation a little of the outer layer of the grain is removed. The loss in weight from cleaning varies from almost nothing to occasionally as much as 2 per cent.

DIAGRAM SHOWING APPROXIMATE YIELD OF DIFFERENT KINDS OF FLOUR AND OFFALS FROM 100 POUNDS OF CLEANED NO. 1 WHEAT.

100 POUNDS CLEANED NO. 1 WHEAT

will yield

VERY NEARLY 100 POUNDS GRAHAM FLOUR;

or

ABOUT 85 POUNDS ENTIRE WHEAT FLOUR AND	15 lbs. BRAN;

or

ABOUT 72 POUNDS STRAIGHT OR PATENT FLOUR,	13 pounds middlings and low grade flour,	15 lbs. BRAN.

THE BRAN.

The diagram shows as refuses from the manufacture of entire wheat flour and straight flour 15 pounds of bran. Are these materials similar, or do they differ so as not to be comparable? Are they *bran* in the botanical sense, as used in the beginning of this paper, or are they bran in the commercial sense, in that they include materials other than the true wheat coverings?

In milling experiments with No. 1 hard northwestern wheat, the wheat and the resultant brans analyzed as follows:

THE COMPOSITION OF HARD WHEAT USED IN MILLING TESTS, AND OF BRAN RECOVERED IN MANUFACTURE OF ENTIRE WHEAT FLOUR AND PATENT FLOUR.

Laboratory number.		Water.	Protein.	Fat.	Carbohydrates: Crude fiber.	Carbohydrates: N-free extract.	Ash.
		Per ct	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
6892	Cleaned wheat (Bran 6894).	9.41	13.63	2.33	2.39	70.33	1.91
6270	Cleaned wheat (Bran 6281).......	11.19	13.75	2.43	1.96	69.02	1.65
6894	Bran from entire wheat flour made from Wheat No. 6892.....	8.43	15.63	5.06	9.67	55.56	5.65
6281	Bran from straight flour made from Wheat No. 6270	10.11	15.50	4.94	10.07	53.06	6.31

The bran, so far as chemical analyses show, are as nearly identical as two brans from the same kind of milling and the same wheat would be likely to run. Under the microscope they equally resemble each other. This agreement in composition of bran produced in milling entire wheat flour and straight or patent flour is only what one would expect, since the processes of manufacture are so similar.

The nitrogen content of these brans is greater than that of the wheat from which they are derived, which indicates that they contain much more than the outer woody coverings of the berry and are, therefore, brans in the commercial, and not in the botanical, sense. Moreover, a microscopic examination reveals the presence of large numbers of the characteristic square cells of the aleurone layer.

A company which claims to be "the originators and only makers of this grade (entire wheat) of flour" state that the "husk to which is attached the fibrous beard and which is composed of silex (flint) and woody fiber, is innutritive and indigestible," and in their process is entirely removed from the berry *before* it is reduced to flour. Unfortunately for the accuracy of this statement, the flour of this brand, like that of all other brands of entire wheat flour thus far examined by us, uniformly contains particles of the seed coatings and fibrous "beard" or brush. The advertisement claims that after these husks and hairs are removed, the remainder of the berry is reduced to an even fineness. Unfortunately again for the accuracy of this statement, the bran from their mill, as well as from all others thus far examined, uniformly contains portions from the layers they claim to retain wholly within the flour. Judged from their advertisement, the bran from their flour would be bran in the botanical sense, and would consist largely of woody fiber and silica, and consequently worthless as food for stock. In point of fact, it is good quality bran in the commercial sense. It is valuable for cattle feeding and carries, as all such bran does, more protein than the wheat from which it was made.

HOW DOES ENTIRE WHEAT FLOUR DIFFER FROM STRAIGHT OR PATENT FLOUR?

Starting from the same wheat, the same bran would be obtained in the manufacture of entire wheat flour as in patent flour. The 85 pounds of entire wheat flour would include the 72 pounds of straight, and the only source of the remaining 13 pounds in the entire wheat flour is the 1 to 2 pounds of second clear and red dog flours, and the shorts or middlings which are separated when patent flour is made. It therefore follows that whatever of nutritive value there is in entire wheat flour that is lacking in patent flour must be sought for in the middlings and low grade flours. These materials are usually higher in protein content than the straight flour. The protein of the most importance in wheat flours is in the form of gluten. The gluten of second clear flour is of poor quality and on this account this grade of flour makes a heavy loaf. The red dog flour is obtained from the germ or embryo and adjacent parts of the kernel. While usually high

in protein, it is dark in color, and because of the poor quality of its gluten has little expansive power and makes a very inferior loaf. The middlings contain much of the germ, the aleurone layer of the bran, and finely ground particles of the outer coatings. It is usually high in protein content, but with practically no gluten. It is probable that much of the laxative qualities noticed in graham flour and which Lawes and Gilbert attributed to the coarse particles of bran, are in realty due to the character of the protein and mineral compounds of the aleurone layer and the germ. For while entire wheat flour is not so much of a laxative as graham, it possesses this property to such a degree that the claims made by some manufacturers that it is a "complete remedy for constipation" would probably hold true in most cases.

The low grade flours and the middlings carry quite high percentages of ash which are valuable in nutrition. All these nutrients found in the low grade flour and middlings enter into the entire wheat flour, and upon them depend the differences between entire wheat flour and patent flour.

ENTIRE WHEAT FLOUR AND STANDARD PATENT FLOUR FROM THE SAME KIND OF WHEAT COMPARED CHEMICALLY.

In the investigations upon the nutritive value of bread made by the Nutrition Division of the Office of Experiment Stations of the U. S. Department of Agriculture, four sets of analyses of the graham flour, the entire wheat flour, and the standard patent flour, manufactured from the same cleaned No. 1 hard northwestern grown spring wheats, and three sets of analyses of entire wheat flour and standard patent flour, manufactured from softer winter wheats, were made and reported in the bulletins of that office. The average of the results of these analyses are given in the table which follows.

THE COMPOSITION OF ENTIRE WHEAT FLOUR AND STANDARD PATENT FLOUR MADE FROM THE SAME WHEAT COMPARED.

Kind of wheat and flour.	Number of analyses.	Water.	Protein (Nx6.25).	Fat.	Carbo-hydrates.	Ash.	Heats of combustion per gram.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
From No. 1 hard spring wheat							
Cleaned wheat or graham flour	4	10.74	14.77	2.26	70.36	1.87	4029
Entire wheat flour..............	4	11.44	14.09	2.01	71.43	1.03	3967
Standard patent flour	4	11.38	13.89	1.44	72.75	.54	3959
From No. 1 soft winter wheat							
Entire wheat flour..............	3	11.18	12.21	1.45	73.95	1.21	3895
Standard patent flour	3	11.54	11.27	.85	75.83	.52	3869

Since the better brands of entire wheat flour found in the market are made from the hard wheat, the first set of figures are the more interesting and instructive. Flour always contains more water than the wheat from which it was made. This is merely another way of saying that the hard outer coatings which go into the bran are drier than the floury interior portion of the berry. Flour, even entire wheat flour, always contains a lower percentage of protein than the wheat from which it was milled. This means that the milling offals always include much of the aleurone and other portions rich in protein. The more than one-half per cent of deficiency in protein content of entire wheat flour, as compared with graham flour from the same wheat, indicates the falseness of the claim that entire wheat flour carries the "constituents "preserved in the flour, precisely in purity and *proportion* as stored in the wheat by nature." The lower protein in the flour means the enrichment of the bran, as was pointed out earlier in this paper. Probably the average standard patent flour would not run as near the entire wheat flour as it happened to in those experiments. From a wheat carrying 14.5 per cent protein, the entire wheat could be expected to carry about 14 per cent, and the standard patent 13.5 per cent protein. The percentage of gluten would, however, be about the same in the two flours.

The entire wheat flour does not carry as much fat as the wheat, but considerably more than the patent. The entire wheat flour

carries about half and the patent flour about one-fourth as much ash as the wheat from which they were made. The greater part of wheat ash consists of potassium phosphate, and the ash rejected in the bran and other offals is as rich in this constituent as that saved for food in the flour. Potassium phosphate is soluble in water, and hence is probably readily assimilated. While comparatively little is known of the function of mineral constituents of the food in nutrition, it is known that they are of importance, and where bread is almost the sole article of diet, the removal of the phosphates in the processes of milling diminishes its value in nutrition. In ordinary mixed diet, where several articles of food are eaten, this removal of the ash would not be of very great importance, as the food of a mixed diet would contain, so far as present knowledge of the function of minerals can be taken as a guide, ample soluble ash constituents for the needs of the body.

The entire wheat flour carries 1 per cent and the standard patent more than 2 per cent more carbohydrates than the wheat from which they are milled. Starch is the most important carbohydrate in wheat. There are also present small amounts of dextrin and sugar. There is also always present in the wheat itself about 2.5 per cent woody fiber, which is valueless in nutrition. The entire wheat flour carries about .75 per cent and the standard patent about .3 per cent of woody matter, or crude fiber, as the chemist terms it.

The heats of combustion of wheat and of the flours differ but slightly from one another. From the available data, the composition of the three classes of flour milled from a wheat carrying 14.50 per cent protein would be approximately as given in the table below. A hard, high grade wheat is used for illustration. If a soft wheat had been used, practically the same relations would have existed.

THE PROBABLE COMPOSITION OF THE THREE CLASSES OF FLOUR THAT A NO. I HARD NORTHWESTERN WHEAT WOULD YIELD.

	Kind of Flour.		
	Graham.	Entire wheat.	Standard patent.
Water, per cent	10.50	11.25	11.50
Protein, per cent	14.50	14.00	13.50
Fat, per cent	2.25	2.00	1.40
Crude fiber, per cent	62.50	.75	.30
Carbohydrates, per cent	68.50	71.00	72.80
Ash, per cent	1.75	1.00	.50
Heat of combustion, calories per pound	1825	1800	1800

THE COMPARATIVE DIGESTIBILITY OF GRAHAM FLOUR, ENTIRE WHEAT FLOUR AND STANDARD PATENT FLOUR.

In the investigations of the Department of Agriculture already referred to, three sets of digestion experiments were made upon the digestibility of breads made from the same wheat milled as graham flour, entire wheat flour, and standard patent flour. The same subjects were used in the experiments with all three flours from each wheat. Milk was the only food eaten with this bread. As its digestibility is better known than that of any other food material, it is possible to calculate from the diet of bread and milk the coefficients of digestibility of bread alone with tolerable certainty. The results are as follows:

CO-EFFICIENTS OF DIGESTIBILITY OF PROTEIN AND AVAILABLE ENERGY OF BREAD MADE FROM GRAHAM FLOUR, ENTIRE WHEAT FLOUR, AND STANDARD PATENT FLOUR PREPARED FROM THE SAME HARD SPRING WHEAT, FOUND AS THE RESULT OF NATURAL DIGESTION EXPERIMENTS WITH THE SAME SUBJECTS.

Kind of bread.	Number of experiment.	Digestibility of protein.	Availability of energy (heat of combustion.)
Graham flour	9	81	83
Entire wheat flour	9	83	87
Standard patent flour	9	89	91

When these coefficients are applied to the figures giving the composition of the three kinds of flour as stated on page 73, the results given in the following table are obtained for the digestible protein and available energy of one kind of each of the flours.

WEIGHT OF DIGESTIBLE PROTEIN AND CALORIES OF AVAILABLE ENERGY THAT ONE POUND OF GRAHAM, ENTIRE WHEAT AND STANDARD FLOURS FROM HARD SPRING WHEAT WOULD SUPPLY.

Kind of flour.	Digestible protein.	Available energy.
	Pounds.	Calories
Graham flour	.117	1510
Entire wheat	.116	1570
Standard patent	.120	1640

From the standpoint of digestible protein that the different flours will furnish, there is but little choice, but what difference there is is in favor of the standard patent bread flour. The standard patent flour supplies rather more available energy than the entire wheat flour. It would take about 104 pounds of entire wheat flour to furnish the same digestible protein and available energy as 100 pounds of standard flour ground from the same kind of wheat.

FLOUR AS FOUND IN THE MARKET.

Graham flour as found in the market is likely to have been made from a soft winter wheat and will carry much less protein than the graham made from hard spring wheat, which is the kind chiefly discussed in the preceding pages. The soft winter wheat graham will usually carry about 12 per cent protein. The entire wheat flours vary with the kind of wheat from which they are made and usually carry ½ per cent less protein than a graham flour would from the same wheat. The leading brands of entire wheat flour are made from No. 1 wheats and carry usually from 13 to 14 per cent protein. The Franklin Mills Entire Wheat flour is the best known in the Maine markets and the

samples examined at this Station carried from 14 to 14.25 per cent protein. Patent flours carry about one per cent less protein than the wheat from which they are made. The standard bread flours of the Northwest carry from 13 to 14 per cent protein. Patents made from hard winter wheats carry 12 to 13 per cent protein, while the protein of soft winter wheat patent flour frequently runs as low as 10 per cent. The Alabama Station* reports two samples of "best grade of white flour offered for sale in Alabama" with 9.22 and 9.24 per cent protein.

There are imitation graham and imitation entire wheat flours on the market which are made by blending some of the poorer kinds of low grade flours, usually from soft winter wheat, with 25 to 30 per cent of wheat offals. The middlings would be used to make imitation entire wheat flour, and to make an imitation graham both the middlings and the bran would be added to the flour. While the dealers claim that these imitations are sold to quite an extent in some sections of the country, it is doubtful if they are in the Maine market. It is, however, more common for bakers to make breads in imitation of graham and entire wheat breads by mixing offals with second clear flour.

Because of the great differences in composition of flours, due not only to the method of milling, but especially to the kind of wheat used in their manufacture, it is impossible to intelligently select and compare different kinds of flour unless the kind of wheat from which they are made is known or brands are selected of known quality.

THE COST OF ENTIRE WHEAT FLOUR TO THE CONSUMER.

As already explained, 100 pounds of hard spring wheat will yield about 72 pounds of standard patent flour, which, in the fall of 1903, retailed in lots of 25 pounds or more for about 2½ cents per pound. One hundred pounds of the same wheat would yield about 85 pounds of entire wheat flour, which retailed in Bangor at the following prices: 5 pound package 25 cents, 12¼ pound package 50 cents, ½ barrel (98 pounds) $3.50, and by the barrel $6.00. According to the size of the package, therefore, entire wheat flour cost the consumer from 3 to 5 cents a pound. The standard patent flour made from 100 pounds of hard spring

* Bulletin 74.

wheat cost the consumer in Maine about $1.80. and the entire wheat flour made from the same amount cost from $2.55 to $4.25. As explained above, the difference between standard patent flour and entire wheat flour from the same wheat is due to the 13 pounds of low grade flour and middlings separated from the former, but included in the latter. The consumer in Maine of entire wheat flour must, therefore, perforce pay from $.75 to $2.45, or at the rate of 6 to 19 cents a pound, for these 13 pounds of low grade flour and middlings. The manufacturers claim that in car load lots they deliver entire wheat flour to dealers in New England at practically the price of standard patent flour, and that this high retail cost is due to the smallness of the demand and consequent lack of competition. Since it costs no more to mill wheat into entire wheat flour than into patent, and since the yield is one-sixth greater in the case of entire wheat flour, the manufacturers should be able to produce it for 25 to 50 cents a barrel less than standard patent. The leading companies claim, however, that a better wheat is used in the manufacture of entire wheat flour than the Minneapolis millers use. Such a claim cannot of course be easily disproved, but so far as the chemical analyses of the flours indicate, it is not well founded. At market prices the digestible nutrients other than ash furnished in entire wheat flour cost the consumer from 40 to 130 per cent more than in standard patent flour. To be sure, he obtains twice as much ash as he would in the patent flours. The function of the ash constituent is little understood, but the present state of knowledge does not warrant the conclusion that the food in ordinary mixed diet is deficient in digestible mineral matter. The use of entire wheat flour for persons in health is not, therefore, as economical as that of white flour. It must be remembered, however, that flour of all kinds is a most economical food, and that entire wheat flour, even at 5 cents a pound, is still a low cost food.

A MILLING EXPERIMENT WITH ENTIRE WHEAT FLOUR.

Chas. D. Woods and L. H. Merrill.

Arrangements were made with the proprietors of a long-established milling plant, who make a specialty of manufacturing a well-known brand of entire wheat flour, to make a milling test upon the yield and chemical composition of the products obtained in the manufacture of entire wheat flour. The whole plant and the services of their experienced miller were kindly placed at our disposal. Much of the advertising of entire wheat flour tends to throw a mystery around its manufacture, and even when definite claims are not made for peculiar processes, the attempt to convey the impression that it differs essentially from the manufacture of bread flour is usually evident. At this mill, and at all mills where we have been given definite information, the cleaned wheat is crushed between rollers and purified in the same way as in the manufacture of patent flour, with the exception that all the product other than the bran is included in the flour. In the experiment here reported, a stand consisting of 8 breaks was used; 3 for flour, and 5 for reducing the middlings and cleaning the bran. The wheat used was No. 1 hard northwestern spring wheat. The wheat, the flour and the bran were sampled for analyses. Samples of the cleaned wheat were drawn from the storage bin, and samples of the flour and bran were taken every 15 minutes during the run. The details of the experiment follow:

Weight of wheat taken...........	1031 pounds
Weight of yield of entire wheat flour	844 pounds or 81.9 per cent
Weight of yield of bran	180 pounds or 17.5 per cent
Loss in milling..................	7 pounds or .6 per cent

As the experiment was made in the midst of a run of a much longer period, the assumption is necessarily involved in the above data that there was the same amount of materials in the mill at

the end as at the beginning. It is probably more accurate to neglect loss in milling and base the percentage yield upon the output.

Calculated on total yield of 1,024 pounds, the yields expressed in percentages are:

Entire wheat flour	82.4 per cent
Bran	17.6 per cent

THE CHARACTER OF THE PRODUCTS.

The yield of entire wheat flour in this experiment was a little above 82 pounds from 100 pounds of wheat. The bran appeared to be very well cleaned and it is probable that the yield could not have been greatly increased from this particular wheat by further treatment. According to available data the yield is somewhat smaller than usual. On the other hand, the flour contained less crude fiber than most samples of entire wheat flour examined at this Station, and under the microscope there was less of the outer layers of bran cells than in most flours of this class. The bran cells and per cent of crude fiber were less than was found in other samples of the output of this mill. The wheat was supplied by an automatic registering apparatus which was set as usual. At the end of the run it was found that the output was somewhat less than customary. This may account for the separation noted, or the difference may have been due to the character of the wheat employed. Wheats, even of the same grading, differ quite materially in the proportion of bran and flour. The bran appeared, both under the microscope and from chemical analysis, to be normal bran, such as would usually be had from milling hard northwestern wheat. Apparently the flour differed from straight patent flour only in containing the middlings, red dog, and second clear flours, which are kept out of the high grade patent. As explained elsewhere (see page 69), the difference in composition and nutritive value of straight patent flour and entire wheat flour is to be explained by the constituents of middlings and low grade flours that are rejected from the former and included in the latter.

The composition of the wheat used in this experiment and the entire wheat flour and the bran obtained as products follow:

COMPOSITION OF WHEAT, ENTIRE WHEAT FLOUR AND BRAN IN MILLING EXPERIMENT.

	On fresh basis.			On water free basis.		
	Wheat.	Flour.	Bran.	Wheat.	Flour.	Bran.
Water, per cent	9.41	13.62	8.43	....	.....	......
Protein (Nitrogen x 6.25), per cent	13.63	12.63	15.63	15.05	14.62	17.07
Fat, per cent	2.33	1.77	5.06	2.57	2.05	5.53
Crude fiber, per cent	2.39	.68	9.67	2.64	.79	10.56
Nitrogen-free extract, per cent	70.33	70.46	55.56	77.63	81.57	60.67
Ash, per cent	1.91	.84	5.65	2.11	.97	6.17
Heat of combustion, calories per gram	4.034	3.822	4.204	4.453	4.425	4.591

In the following table the yield of entire wheat flour and bran from 100 pounds of wheat are shown and the weights of the nutrients. The close agreement of the figures of the two last columns show that the samples of the different portions must have fairly represented the materials, and that the mechanical and chemical parts of the work are trustworthy.

YIELD OF ENTIRE WHEAT FLOUR AND BRAN FROM 100 POUNDS OF WHEAT, AND WEIGHTS OF NUTRIENTS IN THE PRODUCTS COMPARED WITH THOSE OF THE ORIGINAL WHEAT.

	Flour.	Bran.	Total fresh.	Total water free.	In wheat.
Yield in pounds	82.40	17.60	100.00	....	.....
Water, pounds	11.22	1.48	12.70	....	....
Protein (Nitrogen x 6.25), pounds	10.41	2.75	13.16	15.08	15.05
Fat, pounds	1.46	.89	2.35	2.69	2.57
Crude fiber, pounds	.56	1.70	2.26	2.59	2.64
Nitrogen-free extract, pounds	58.06	9.79	67.85	77.72	77.63
Ash, pounds	.69	.99	1.68	1.92	2.11
Calories per gram	3.149	.740	3.889	4.456	4.543

The distribution of the nitrogen and ash of the wheat in the products is as follows:

80 per cent of the nitrogen of the wheat was found in the flour;
20 per cent of the nitrogen of the wheat was found in the bran.
42.5 per cent of the ash of the wheat was found in the flour;
57.5 per cent of the ash of the wheat was found in the bran.

FERTILIZATION PROBLEMS: A STUDY OF RECIPROCAL CROSSES.

M. B. Cummings.

In attempting to account for failure in the making of reciprocal crosses one faces a perplexing problem. The number of cases in which reciprocal crosses cannot be made is small, when compared with that of successful ones. It is not the number of successes or failures, however, which gives the subject prominence. It is not the fact of failure in one case and success in another; but rather the reason for such failure. If we can cross plant A with plant B, why can we not cross plant B with plant A? What is the immediate cause for the refusal of certain plants to cross reciprocally, and how does their refusal manifest itself? To find a satisfactory answer to these questions is the purpose of this investigation.

I. Records of Previous Work.

SOME IMPOSSIBLE RECIPROCAL CROSSES.

No exhaustive list of supposed impossible reciprocal crosses is attempted at this time, since a few cases will serve the purpose of presenting the problem. Kölreuter[1], during a period of eight years, made repeated trials to secure reciprocal crosses with *Mirabilis jalapa* and *Mirabilis longiflora.* He tried more than two hundred times to fertilize *Mirabilis longiflora* by applying pollen of *Mirabilis jalapa,* but without success. The pollen of the former when applied to the stigma of the latter, however, produced fertile seeds. The same difficulty is met with when an

1. Cited by Webber and Swingle. Hybrids and Their Utilization in Plant-Breeding, Yearbook Dept. Agr., 1897, p. 383.

Note. This paper is part of an investigation which has been in progress for the past 12 years by Professor W. M. Munson, Horticulturist to the Station, upon the effects of pollination. Beginning with 1892, occasional reports of progress have appeared in the bulletins and reports of this Station. The studies here reported upon were conducted under Professor Munson's direction.

attempt is made to reciprocally cross *Matthiola annua* and *Matthiola glabra,* two closely related species.[1]

Thuret[3] is authority for the statement that *Fucus vesiculosus* crossed by *Fucus serratus* is fertile, but that reciprocal crosses with these plants cannot be made. Strasburger[2] found that *Orchis fusca* pollen will stimulate the ovules of *Orchis Morio* into normal activity, while pollen of *Orchis Morio* will not form tubes on the stigma of *Orchis fusca.*

Among more familiar plants, other supposed impossible reciprocals are the red currant and common garden tomato, and summer crookneck and bush scallop squashes. These cases will be discussed in detail later in this paper.

PROCESSES LEADING TO THE FORMATION OF SEED.

In order to pave the way for a study of abnormal conditions, it will be well at this point to review in a general way the normal process of fertilization.[3]

It is now well known that the pollen grain, after being lodged on the sticky surface of the stigma, undergoes a process similar to that of the germination of spores of the lower orders of plants, and not greatly unlike that of the germination of seeds. Soon after the deposit of the pollen, the grains absorb moisture and increase in size; the outer wall, the extine, bursts, and inhibition of watery solutions incites to activity the protoplasm of the grain, and movements of cytoplasm within cause the extension of the inner wall so as to form a tube, the so-called pollen tube. Now the pollen tube, once started in its downward course, makes its way through or between the parenchyma cells of the pistil, manifesting its growth by the formation of new nuclei in the protoplasm, and in the extension of the wall in the form of a tube. This tube penetrates to the region of the ovules and when the micropyle is reached the pollen nuclei pass into the embryo-sac, and a union of the elements is effected which results in the formation of seed. Germination when once started may be completed in a few hours, as in the case of *Cereus grandiflorus;* or it may require several months, as in the case with orchids; or almost a year, as is true with the pines.

1. Cited by A. R. Wallace, Darwinism, p. 155.
2. Cited by H. P. Gould, Potency of Pollen, Cornell University Thesis, 1897, p. 28.
3. Cf. also, Rpt. Maine Agr. Expt. Sta., 1898, 219, et seq.

Just how the pollen tube is nourished, how it is guided to the ovarian region, and what finally brings the elements together, is still very largely a matter of theory and conjecture. However, imperfect as our knowledge is concerning these points, numerous observations on various stages and types of germination, enable one to make a few very general remarks on the above questions.

As regards the nourishment of the tubes, it is known that there are two probable sources of food. The pollen grains contain some elements for nourishment, and the conductive tissue is not entirely without food. From chemical analyses it has been shown that pollen cells contain a certain amount of nutritive material such as starch and maltose, in connection with some invertase and diastase to render them available for the nutrition of the pollen tubes. On the part of the pistil and its conductive tissue there is an abundant supply of elaborated food materials such as starch, sugar, and maltose, which, without doubt, are of much value in nourishing the tubes in their passage to the ovules.

It is very probable that the development and action of enzymes facilitate the descent of the pollen tube, and the discovery of a cytolytic enzyme by Marshall Ward[1] in a species of Botrytis, throws further light on the problem of the penetration of tubes.

An analysis of the factors which facilitate the descent of pollen tubes and finally enable them to reach the ovules shows them to be of at least two sorts. First, mechanical contrivances; and secondly, stimulating influences or attractive substances which cause the union of the elements. The mechanical features include the nature of the conductive tissue which, as we know, is a system of thin walled cells through which the pollen tubes pass, growing as they naturally would in the lines of least resistance. Other features of a mechanical nature are also useful; such as papillæ, which are common in the pistils of Cucurbitaceae; and the position of the funiculus and the ovule itself.

The second set of factors, the stimulating or attractive substances, do not admit of as easy demonstration. As a matter of fact, just what actually brings the male and famale nuclei into contact is not known. However, a few probable suppositions may be mentioned here and left for further discussion and investigation.

1. H. Marshall Ward, Annals of Botany, II, 1888.

During the period of receptivity of the pistil and descent of the pollen tube, deep seated changes are going on in the ovary which prepare the ovules for the fertilizing process. This preparation consists in the formation of an organ in the nucellus of the ovule called the embryo-sac, an exceedingly important structure during fecundation. This embryo-sac consists of several parts, which may be referred to as follows: At the micropylar end of the sac is the egg apparatus, which consists of two cells, the synergidae, and another the germ cell or oösphere, which, after fertilization, becomes the embryo. At the opposite end of the sac there are three cells, the antipodals, which are of lesser importance. But the egg apparatus is the dynamic center; and it is supposed that this structure exerts a stimulating influence as the male nucleus nears its destination, the supposition being that a fluid escapes from the synergidae which attracts the pollen spore and unites the elements.

In studying the approach of sexual organs Pfeffer[1] has demonstrated that the spermatozoids of ferns are enticed into the necks of the archegonia by means of malic acid; and the archegonia of mosses attract the spermatozoids by a solution of cane sugar. Before leaving this point, reference should be made to the statement of Strasburger[2], who would explain the fusion of the male and female elements as due to chemitactic and chemotropic influences; the explanation being that the nature and strength of solutions in the pistil and in the vicinity of the ovules attract or repel the pollen tubes.

DETERMINING FACTORS, IN CASES OF ABNORMAL FERTILIZATION.

The nature of the problem under consideration necessitates the study of certain factors which may influence in some way the making of the crosses. The factors here considered are:

A. Incomplete development of pollen tubes, due to
   (1.) Impotent pollen or poisonous stigmatic fluid, or
   (2.) Lack of nourishment of pollen tubes.

B. Non-fusion of nuclei.

1. Cited by Wilson. The Cell in Development and Inheritance, p. 197.
2. Strasburger, Text-book of Botany, pp. 263, 281.

A. Incomplete Development of Pollen Tubes.

(1.) Impotent pollen or poisonous stigmatic fluid.

The study of this feature of the problem had its origin mainly with the investigations of Darwin[1] and no systematic study of self-sterility was taken up till after the publication of Origin of Species in 1859. While horticulturists and other investigators were studying the causes of sterility for many years, it was not till quite recently that the histological study of sterility was begun. Even though the general causes of sterility have been pretty well worked out, yet the details of the problem,—the non-development or incomplete development of the pollen tubes,—is, so far as the writer's knowledge is concerned, still unexplained.

It is well at this point to refer to the investigations of the pioneers on this subject. Darwin, for example, found that in the case of legitimate and illegitimate union of the elements in *Linum perenne,* if pollen of either form be placed upon its own stigmas, the pollen grains would germinate and the tubes enter the tissue of the pistil, but to what extent is not known. Darwin observed here that the impotency of the pollen must be due either to the tubes not reaching the ovules, or to their improper action upon reaching them.

Again, in the case of *Linum grandiflora* where other unions, legitimate and illegitimate were made, it was ascertained by examining the pistils that the pollen of illegitimate unions germinated very rarely, and in those where germination did take place the tubes were short and penetrated the tissue of the pistil only a short distance.

In other cases the pollen seems to be absolutely impotent, and in such cases the trouble seems to lie in the inability of the stigmatic secretion to properly excite the pollen in such a way as to form tubes. This has been found to be the case with some of the Orchidaceae where self pollination results in the death of the flower. Fritz Müller[2] says that pollen masses and the stigma of the same plant in various species of Orchidaceae have actually a deadly effect upon one another, as in the case of *Oncidium oscrohilum.* This was shown by the surface of the stigma in contact with the pollen, and by the pollen itself becoming dark and

1. Darwin. Different Forms of Flowers on Plants of the Same Species. Chap. 1, 2, 3.

2. Fritz Müller, Bot. Ztg., 1868, p. 114.

decaying in from three to five days after pollination. Again with *Oncidium flexuosum*, the plant's own pollen and that of a distinct species were placed side by side, and after five days the latter was perfectly fresh, while the plant's own pollen was brown. These observations are remarkable, for they show that the plant's own pollen not only fails to impregnate the flower, but acts on the stigma, and is acted on in an injurious or poisonous manner. Such action seems to be mutually poisonous.

In 1897 Gould[1] confirmed the work of the older investigators. At the conclusion of his thesis he says: "The power of pollen to produce fecundation exists in every possible degree from perfect potency to absolute impotency. Pollen, like seeds, may be so low in degree of vitality as to be unable to germinate, or be so retarded in its germination that the elements do not come together till the period of receptivity is past. External conditions such as temperature and moisture may influence the vitality of pollen and its potency."

Some recent work by Booth[2] concerning the self-sterility of grapes throws further light on the inactivity of pollen. Results of experiments carried on for several years are summarized in this manner: Poor pollen may be known by a microscopical study of the structure of the grains; the infertile grains are irregular in shape and have sharp angles,—also by the arrangement of pollen, either dry or in fluid media. Fertile pollen comes together in clusters by means of its mucilaginous coatings. Sterile pollen does not have this coating, and comes together only by chance. Culture experiments showed the self-sterile pollen to be lacking in viability, for in most cases such pollen either failed to germinate or gave a low percentage of germination. Such pollen was impotent on pistils of self-sterile varieties, as well as on its own stigmas. Booth explains the reason for this condition of things, as a probable indication that the flowers of the grape are in an evolutionary stage, and are passing from hermaphrodite to staminate and pistillate forms. Mention of these cases is made here to show how infertility is expressed, for the problem of impossible reciprocates bears hard on the subject of sterilty.

(2.) Lack of nourishment of pollen tubes.

1. H. P. Gould, Potency of Pollen, Cornell University Thesis, 1897.
2. N. O. Booth, N. Y. Agr. Exp. Sta. Bul. 224. A Study of Grape Pollen

It is generally conceded that the descent of the pollen tube is largely dependant on the nature of the stigmatic fluid as a medium for the germination of pollen. During the descent of the tubes certain enzymes are developed; and while the exact nature and importance of these is not worked out, it is thought that they exert a considerable influence on the growth of pollen tubes. If this influence is correct, it follows that unless these nutrients are such as to develop proper conditions for germination, the penetration by pollen tubes cannot be effected. To what extent this will account for failure in making reciprocal crosses is still an open question. It is difficult to understand why trouble should occur in the nourishment of the germ tubes only when certain pollen is used, and not in all cases, and yet a slight disturbance of the sexual organs may be of considerable importance in this connection.

B. Non-fusion of Nuclei.

Whatever reasons there may be for failure in fertilization, it is certain that fecundation cannot be effected unless there is a fusion of male and female nuclei. The fusion of the nuclei takes place only when the pollen tubes develop in such a way as to allow the male nucleus to pass into the öosphere. Pollination and development of pollen tubes may take place and yet fertilization fail to occur. A few instances from other investigations will bear out this statement. Mr. John Scott[1] observed that in the case of *Oncidium sphacelatum* self pollination did not produce capsules, although the stigmas were penetrated by pollen tubes.

Furthermore, in another species, *Oncidium microhilum,* the pollen was good, for with it he fertilized two distinct species; he found its ovules good, for they could be fertilized with another plant of the same species, but this species could not be fertilized with its own pollen, although the pollen tubes penetrated the stigma.

In 1900 Fletcher[2] noted that self-fertile varieties of plums —miner and wild goose—were infertile on each other. In the case of the wild goose plum the pollen germinates, and the tubes pass down to the ovules, but for some reason the two sexes fail

1. Scott, Journal of Proc. Linn. Soc., Vol. III.
2. S. W. Fletcher, Cornell Univ. Exp. Sta., Bul. 181.

to unite. Gould[1] reported a similar case where crookneck squash was pollinated with bush scallop. There was a vigorous development of pollen tubes, since they passed in the vicinity of the ovules, but there was no fusion of the nuclei.

SUMMARY.

In summarizing those cases in which reciprocal crosses have failed, we may note that in some cases pollen tubes do not develop, in others there is a partial germination, and in others still there is a vigorous development of tubes; but in none of these cases is there fusion of the nuclei.

II. Studies by the Author.

A. RED CURRANT AND YELLOW PLUM TOMATO.

The difficulty which has been experienced in making reciprocal crosses with red currant tomato, *Lycopersicum pimpinellifolium,* and varieties of *Lycopersicum esculentum,* has given rise to the notion that such reciprocals cannot be made. Wishing to know the facts in the case, the writer began investigations with the following points in view. First, to see if reciprocal crosses with these plants can be made. And secondly, if this is impossible, to find out what constitutes the difficulty.

Plants for this work were grown in the University greenhouse. Seeds of yellow plum and red currant tomatoes were planted in flats, and as the seedlings attained proper size they were transplanted, some into large pots and others into large boxes. As soon as the blossoms appeared, a study of the sexual elements was begun. For the first few weeks following the appearance of the flowers, much time was spent in a study of the pollen of these plants. The results of this investigation are given below.

(1.) A comparison of pollen.

In attempting to account for failure in crosses, one is apt to consider pollen as the source of trouble. In view of this fact, a structural and germinative study of pollen was made. Pollen from flowers of the kinds mentioned above was examined in dry and fluid mounts, but no differences in form or structure could be detected. Although the pollen from both species was to all

1. H. P. Gould, Studies in Potency of Pollen, Cornell Univ. Thesis, 1897.

appearances precisely alike, germinative tests were made to note any differences in rapidity and per cent of germination. For this study sugar solutions of 1, 2, 3, 5, and 10 per cent were taken as culture media. It seems remarkable that plants which are so different in gross structure should show absolutely no difference in structure of their pollen, or in per cent and rapidity of germination. In all cultures, however, the protoplasm streamed out in much the same manner, and measurements were made of the length of pollen tubes, but even here no difference could be detected.

A study of pollen of yellow plum was furthered by making close-pollinations, without emasculating, and covering the flowers to prevent access of foreign pollen. In nearly every case the pollen did its work, for the fruit set and came to maturity. Treated in a similar way flowers of red currant gave similar results.

(2.) Trouble with pistils.

In view of the foregoing study and its results, the writer was convinced that the trouble lay, not with the pollen, but probably with the pistils, or in combining yellow plum pollen and red currant pistils. By this time the process of emasculation was begun, and here great difficulty was experienced. It seemed almost impossible to emasculate the red currant without destroying the upper portion of the pistil. This trouble led to a comparative study of the pistils of red currant and yellow plum. This comparison has revealed the major reason for inability to cross the plants.

The pistil of the red currant is considerably smaller than the yellow plum, as can be seen with only a superficial examination; but a more careful study reveals the fact of minor differences which are of considerable importance. The most striking difference, aside from that of size, is to be found at the junction of style and ovary. At this point, in the case of red currant, there is a constriction in the pistil, which is much narrower and is placed in a slight depression in the ovary. A critical examination, however, shows no joint, although there is a slight dissimilarity in size and structure of cells. The style of the red currant is, then, largest half way between the ovary and stigma, that is, it tapers toward the stigma and also toward the ovary.

The pistil of the yellow plum, on the other hand, is continuous with the tissue of the ovary and does not exhibit that narrowed structure which is seen in the red currant; but, in fact, is larger and broader there than elsewhere.

This comparison brings up the mechanical feature in crossing these two species. Here, then, one may note that the red currant flowers can be successfully emasculated only by exercising great care, on account of the ease with which the style separates from the ovary, a slight push to one side being sufficient to detach it. Furthermore the pistil is very slender and exceedingly delicate, and being deprived of the protection which the united stamens afford, it is exposed to changes of temperature and moisture which in most cases are fatal to the pistil.

In successful emasculation of red currant, and with the ordinary method of covering the flowers with paper bags, it was practically impossible to keep the pistils fresh till the period of receptivity. In the majority of cases the pistils withered in the course of twenty-four hours after emasculation, and hardly a single one could be found in perfect condition three days after the removal of stamens. Even when the pistils did survive and were pollinated they did not remain fresh long enough for the pollen to do its work.

In view of these difficulties, it became evident that some means should be provided to prevent the withering and dying out of the pistils. Instead of covering each cluster of flowers with manilla bags, glass bell-jars which covered the whole plant were used, thus eliminating to a marked degree the exposure of the pistils, and securing a fairly uniform condition of moisture and temperature. It should be said here that this scheme was feasible only by using small plants and very large glass bell-jars. By thus protecting the flowers, and in fact the whole plant, less difficulty was experienced in keeping pistils in good condition as long as seemed necessary. Nearly as good results were obtained by using double paper bags, and similarly covering the whole plant. Such good results followed these special methods that the real difficulty in making these reciprocal crosses was considered to be mechanical, and this difficulty can be very largely overcome as previously indicated.

Seeds saved from fruits of these reciprocal crosses, produced fertile plants, and thus we have an answer to our opening ques-

tions: Reciprocal crosses of red currant and yellow plum can be made; but special care must be exercised in emasculating the flowers of red currant, and the pistils must be protected from injurious effects of changes of temperature and moisture. The real difficulty in making these reciprocal crosses is a mechanical one, and lies in the delicate structure of the pistil of the red currant.

B. A STUDY OF SQUASHES.

All the previously mentioned impossible reciprocals are those between distinct species; but with the squashes we have more closely related plants, the summer crookneck and golden custard being horticultural varieties of the same species, *Cucurbita Pepo,* a condition which makes the problem all the more remarkable and adds greatly to the interest of the inquiry for facts in the general problem of impossible reciprocals.

(1.) The field work.

The time when this work was done, and the conditions under which the material was obtained, lend latitude to the problem. Some of the plants for this study were grown in the University greenhouse in the winter and spring of 1903, but most of the material was obtained from plants grown in the garden under normal conditions of culture. Plants which were grown out-of-doors were planted June 18 and began to blossom August 10. Staminate flowers were the first to appear, and at this time a study of the pollen of the two varieties was taken up, which will be described in the histological part of this subject.

Pollinating the Plants—The flowers of the squashes are of exceedingly short duration; the corolla remains open only one day, and generally somewhat less than twenty-four hours. Such short lived flowers necessitated daily attendance in the squash plot in order to do the pollinating when the staminate and pistillate flowers were in prime condition for the operation. Note should be made here of the great care that was taken in securing pure fresh pollen, and applying it to the pistils that were at their height in the period of receptivity. Since the flowers exist only for a short time, pure pollen was easily secured by tying a string over the tip of the corolla the day before the flower opened, thus preventing access and mixture of pollen. Pistillate flowers were

protected in the same way—the stigmas were never exposed except for the moment when pollen was applied to them.

Other methods of protecting the flowers were tried, such as covering with paper bags and glass bell-jars, but were found less satisfactory owing to the fact that a close atmosphere for the entire flower seemed to hasten decay of the pistils, thus shortening the age of the flower and giving less time for the action of pollen. No pollen was used that was more than twenty-four hours old; and all pistils were discarded, which, because of age or structure, were unfit for pollination work.

By actual count, 284 pistils of crookneck squash were pollinated with golden custard. Of this number about one-third were picked off at various stages, and preserved for microscopical study. The rest were left on the vines as long as they remained intact. As would be expected in any case of artificial pollination, a large number of the crosses were a complete failure, as was evidenced by the early death of all parts of the flower. In a few cases, however, the ovary made an unusual growth, due, it was thought, to the scarcity of blossoms, and to the vigor of the plants; and as interesting results were in sight, these fruits were left till frost killed the vines.

No apparent difficulty was experienced in crossing golden custard with crookneck; and pistils of each could be fertilized with pollen of its own kind and from the same plants, but pollen of golden custard would not act on pistils of crookneck. Facts of this nature seemed to indicate that the difficulty lay, not with poor pollen in either case, nor with poor pistils, but rather in the way they were combined.

(2.) Histological studies.

This feature of the work was begun by a study of dry pollen, pollen in fluid mounts, and germinating pollen grains. In this work all study was comparative. Pollen of crookneck and golden custard was taken to the laboratory and examined with high and low power objectives, with grains in dry and fluid mounts; but in size, shape and surface markings the pollen of the two varieties was precisely alike. Pollen grains of the squashes do not germinate readily in artificial media, and because of this fact a study of germinating pollen was attended with poor success. A careful examination of the male elements of the squashes adds nothing to the solution of the problem.

Pistils of crookneck pollinated with golden custard, representing all possible stages, were picked; beginning with those of 24 hours' duration and passing up to those which had been pollinated 7 and 8 days. Pistils generally remain fresh 3 to 4 days, and in some cases they did not show decay till the fifth day after pollination. Of self pollinated and cross pollinated flowers there seemed to be no difference in duration of flowers. In many cases pistils were left on the plant till the stigma and style had decayed and fallen off; in such cases only a portion of tissue, that immediately surrounding the ovules, could be preserved, but this was actually necessary in order to give pollen tubes—if they did germinate and enter the ovarian region—a chance to act, and furthermore to give the investigator an opportunity to study the final action of such tubes.

Of course a study of the germination of pollen tubes necessitated a large amount of histological work, and in order to get material in condition for this study the following method was followed: Pistils were picked, trimmed so as to avoid all unnecessary tissue, killed, and fixed in a one per cent solution of chromo-acetic acid for 30 hours, washed an equal length of time in tap water, hardened and dehydrated in alcohol of 35, 50, 70, 95 per cent solution, and finally in absolute alcohol. The alcohol was replaced by xylol, and the pistils were then imbedded in paraffin. Sections were cut at thicknesses varying from three and one-third to twenty micro-millimeters; twenty micro-millimeters proved the most satisfactory. The three-color-stain—Flemming's safranin, gentian-violet, and orange G. was used. The tissues were mounted in balsam and finally studied with the microscope.

The object of making and examining these sections of the pistils and ovaries was to ascertain if possible, some reason why fecundation failed to occur, the chief aim being to trace the pollen tubes, if formed, from stigma to ovules. The tracing of pollen tubes is a comparatively easy thing to do, provided the tissue is properly handled and successfully stained. The triple stain previously mentioned proved especially good for this work. In this case the cytoplasm of embryo-sac and pollen tube stains from gray to orange, the nucleus violet, and nucleolus red. Besides being different in color, the pollen tubes are distinguished by the peculiar granular structure of their protoplasm.

The germination of golden custard pollen on pistils of crookneck, is not a rapid process. On an average the tubes have to pass through one and three-eighths inches of tissue, and it generally takes about 8 days for the generative nucleus to reach the embryo-sac. In other words the tubes descend at the rate of four and one-fourth millimeters per day. Germination of pollen begins very soon after the deposit of the grains on the stigma, for at the end of 24 hours many of the tubes have attained a length equal to twice and in some cases three times the diameter of the grain. Before the end of the second day the vegetative nucleus has passed into the tube, and soon after this the generative nucleus has also started on its downward course. During the two following days the tubes continue to descend, and oftentimes they branch to some extent. From this time on nothing important happens till the male protoplast reaches the ovarian region and comes in the vicinity of the micropyle. This occurs about the sixth day, or sometimes between the fifth and seventh days. Before the end of the eighth day the generative nucleus has passed the vegetative, enters the embryo-sac, and finds a resting place near the germ cell. This seems to be the final action of the pollen spore, for tissue nearly ten days old shows the same condition as that which has been pollinated eight days. This seems to give a key to the situation. Pollen grains germinate, pollen tubes descend, the pollen spore enters the embryo-sac; but the nuclei do not fuse. Fertilization does not occur. The reason for failure is, apparently, a refusal of the embryo of crookneck to be impregnated by pollen spores of the other variety.

It now becomes evident that where there is no incompatability in the structure of the flowers, where no mechanical difficulties exist, and when the pollen tubes descend and enter the ovarian region, the reason that certain reciprocal crosses cannot be made, is non-fusion of male and female nuclei. The elements do not come together, although the protoplast of the pollen grain arrives, that is, in many cases it enters the embryo-sac.

In some cases the nuclei are some distance apart in the embryo-sac while in others the distance which separates them is only twice their diameter. Such cases are quite common. Now, with these facts before us, we are confronted with the question

as to which element, male or female, refuses to fuse with the other. In other words, does the pollen spore fail to take, or does the germ cell fail to receive? From the nature of the case we suppose that the germ cell will not receive; for the male nucleus has arrived, and therefore, has seemed to have done its work. That the failure to fuse is not due to a difference in structure of the nuclei, is shown by the microscope. The nuclei, so far as the microscope reveals, are of precisely the same size and shape. So that the dissimilarity or differentiation of gametes, if such exist, must be sought in characters which are probably constitutional, perhaps chemical, in nature.

It has been suggested that the reason why the elements do not unite is because there is a lack of affinity in the plants crossed. But an explanation of this sort does not explain, for we hesitate to define lack of affinity. It is well to refer here to the statements that closeness of relationship marks the limit of successful grafting. And the same thing may be said in regard to the limits of crossing. As a rule, only closely related plants can be crossed. Affinity, resemblance, or likeness, allows the union of similar parts. Dissimilarity or unlikeness prohibits union. Now, if we return to reciprocal crosses, we find it difficult to make the application. How is it that the golden custard squash is so like the crookneck that it will receive its pollen and bear seed; but the crookneck be so unlike the golden custard as to refuse to be fertilized by such pollen? If such conditions exist, they must be centered in the sexual elements, the gametes.

In speaking of the delicate adjustment of plants, Wallace[1] has suggested that the reason certain plants refuse to cross reciprocally, is an indication of disturbance of the sexual organs. Very likely there is a germ of truth in this suggestion, and we might add that the sexual organs of impossible reciprocals are in a state of unstable equilibrium. This seems rational from the nature of the case; but what is disturbed? Is it the molecular swing of the basis of life? Is some constitutional character disturbed? Or is there a disturbance in one or both cases? This feature of the problem must remain as a matter of conjecture.

Since there does not appear to be a difference in structure of the gametes, it is at least possible that a disturbance has taken

1. Alfred R. Wallace, Darwinism, page 155.

place which has resulted in some chemical differentiation. If this theory is tenable, fusion is prohibited because the chemical stimulus which unites the elements is impaired or destroyed. Some slight change in the chemical composition of the gametes or of the embryo-sac, perhaps both, would disturb the equilibrium and impair the forces which cause fusion. As it now appears, the egg-cell of crookneck is indisposed toward pollen spores of golden custard, that is, there is a manifest expression of selection with crookneck pistils. Not all pollen is congenial, some pollen spores will not be received, and among these non-receptive gametes are to be included those of golden custard. In other words, this is apparently an example of what has been called "sexual elective affinity."

(3.) Some products of the crosses.

When the fruits mentioned above had come to full maturity they were cut open and in some cases many seeds were found which appeared to be well formed. Such results were surprising, but were not to be accepted as demonstrations that these reciprocal crosses can be made, until the fertility of the seeds had been determined and the character of the offspring observed.

The seeds were dried and planted to determine if they were viable; and if so, to ascertain if the offspring were also fertile. The seeds were planted in the greenhouse, and the following is the record of their germination.

No. of the fruit.	No. of seed produced.	No. of seeds planted.	No. of seeds germinated.	Per cent germinated.
1	195	25	5	20
2	160	25	0	0
3	33	25	5	20
4	40	25	5	20
5	37	25	15	60
6	56	25	14	56

The higher percentage of germination in the last two cases may be accounted for by the more careful selection of seed; only the best were planted. The above figures are of value in showing the degree of viability of the seeds.

Bringing forward the figures previously used we have the following statement: Of 284 pollinations more than 200 pistils were left on the vines as long as they remained intact. From

these 200 pistils 18 well formed fruits were obtained; of the 18 fruits only 6 produced seeds with embryos, and from these 6 only 5 contained fertile seeds. Germinative tests of these seeds showed on the average that 30 per cent were viable. These facts emphasize the importance of a practical study of the obscure problems concerning plant development as opposed to generalizations from a study of the minute structure of the organs.

From the foregoing results the following statements seem reasonable:

I. Reciprocal crosses with crookneck and golden custard squashes are not absolutely impossible.

II. Golden custard pollen varies in its degree of potency and shows all possible stages, ranging from perfect fertility to perfect sterility. These stages are shown in the decay of crookneck pistils, when pollinated with golden custard; in microscopical sections of such pistils; in the partial and complete development of fruit and seed; and in the sterility and fertility of seed.

GENERAL SUMMARY.

From the foregoing investigations the following conclusions seem justifiable:

Failure in making reciprocal crosses may be explained by some incompatibility in the structure of the flowers. Such barriers may result from delicate structures, and constitute mechanical difficulties.

Failure of pollen to produce fecundation may be explained by the incomplete development of pollen tubes, or, in cases of complete development, by the non-fusion of nuclei.

Failure in the fusion of male and female nuclei is indicative of disturbance of the sexual organs. Such disturbances may be chemical, but are probably constitutional in nature.

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DESCRIPTION OF PLATES.

Figure 10. Male blossom of squash tied to insure purity of pollen. See page 91.

Figure 11. Female blossom of squash (Crookneck) previous to pollination; tied to prevent accidental crossing. See page 91.

Figure 12. Longitudinal section of Crookneck and Golden Custard squashes, at time of pollination.

Figure 13. Crookneck crossed by Golden Custard, at maturity. No. 2 mentioned on page 96.

Figure 14. Crookneck crossed by Golden Custard, at maturity. No. 4 mentioned on page 96.

Figure 15. Crookneck crossed by Golden Custard, 14 days after pollination. No ovules were fertilized and the fruit had begun to decay.

Figure 16. The offspring of Crookneck crossed by Golden Custard. Note the intermediate characters.

Figure 17. Golden Bush crossed by Hubbard. Illustrating the possible stimulating effect of pollen upon the ovary in the absence of fertilization. No fertile seeds were produced.

Figure 18. Stigmas of Red Currant and Yellow Plum tomatoes. See page 89.

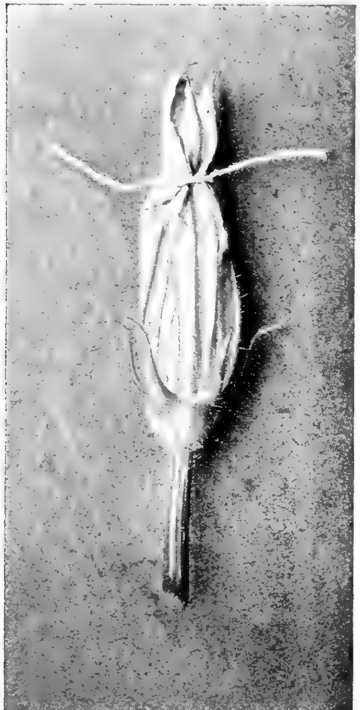

Figure 10.

Figure 11.

Figure 12.

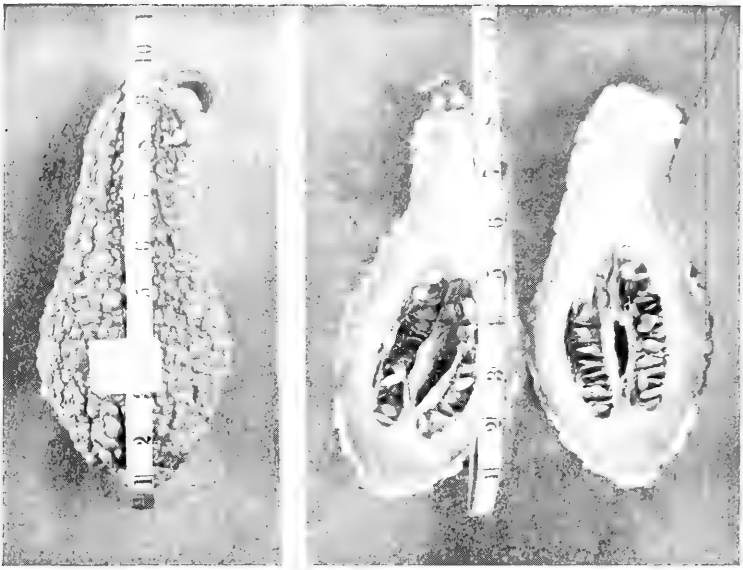

Figure 13.

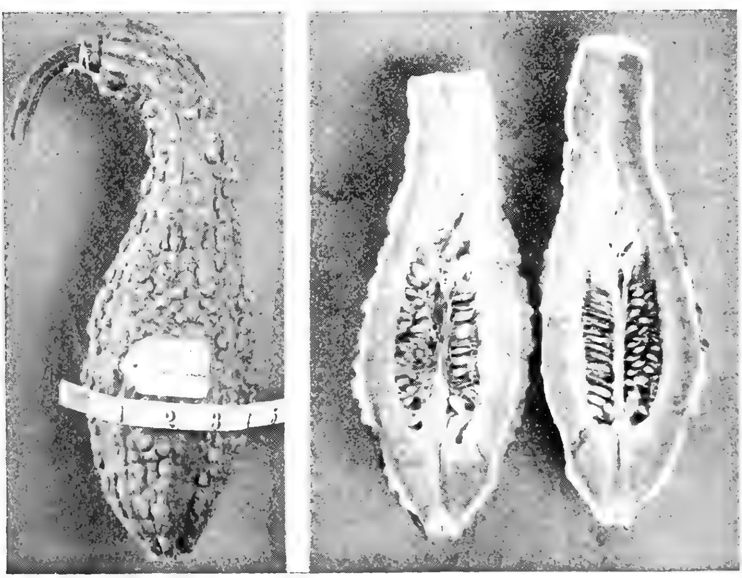

Figure 14.

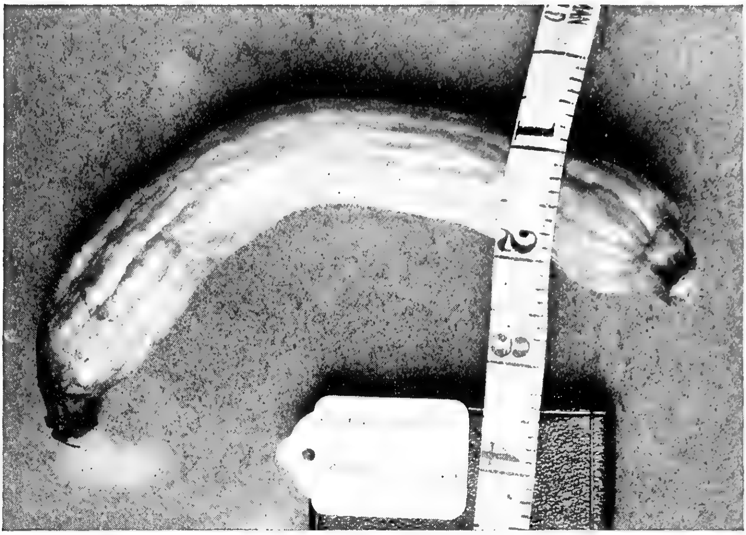

Figure 15.

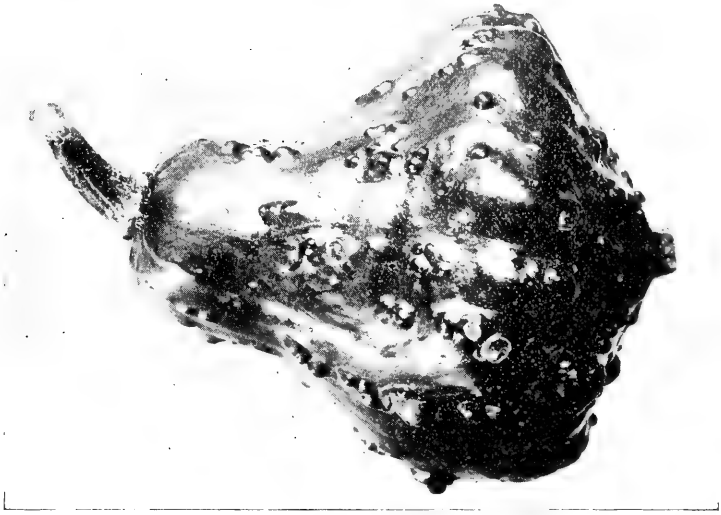

Figure 16.

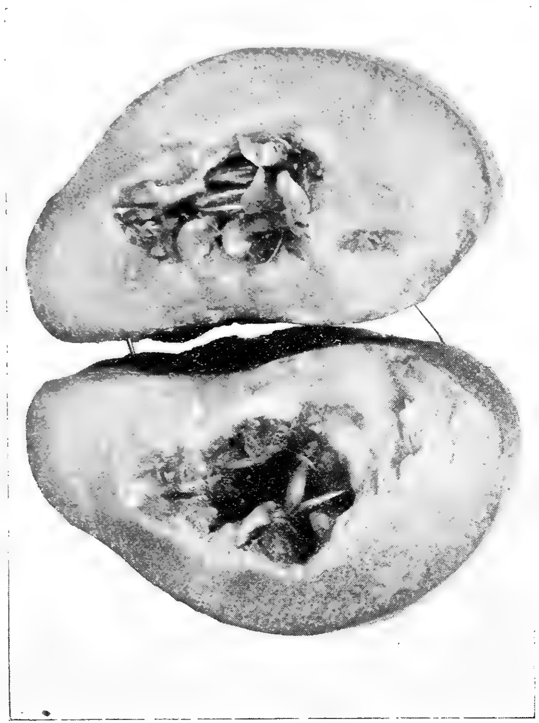

Figure 17.

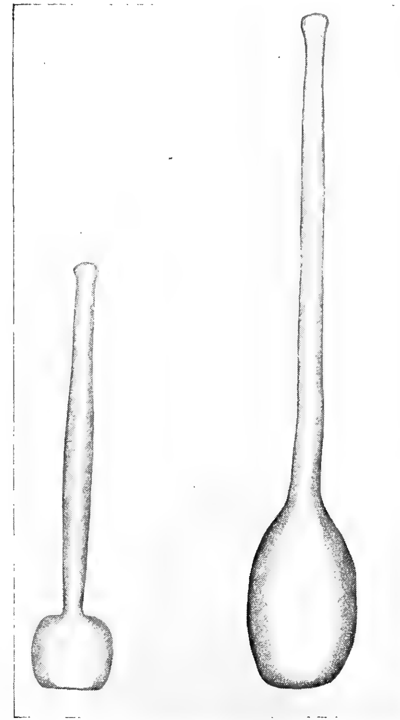

Figure 18.

FERTILIZER INSPECTION.

CHAS. D. WOODS, Director.

J. M. BARTLETT, Chemist in charge of Fertilizer Analysis.

The law regulating the sale of commercial fertilizers in this State calls for two bulletins each year. The first of these contains the analyses of the samples received from the manufacturer guaranteed to represent, within reasonable limits, the goods to be placed upon the market later. The second bulletin contains the analyses of the samples collected in the open market by a representative of the Station.

The analyses of the manufacturers' samples for this year were published in March. A number of samples were received so late that the analyses could not be included in the bulletin then issued. The results of these analyses will be sent on application.

In the following tables are given the analyses of the samples of commercial fertilizers collected in the open market in the spring of 1904 by the Station representative. As far as possible two samples of each brand were taken, an effort being made to get the duplicate from a distinct lot of the same brand in a different part of the State. If the first sample of a brand analyzed fell below the guarantee, the duplicate of that sample, if one were at hand, was also analyzed. Consequently the analyses of about fifty duplicate samples appear in the table. In some instances the second analysis agrees quite closely with the first, but frequently it is quite different, indicating that the goods are subject to considerable variation.

An inspection of these figures shows that a large number of the brands do not come quite up to the guarantee. This is especially true of some companies and while in most instances the deficiency is slight, yet the differences are greater than

[Continued on page 112.]

DESCRIPTIVE LIST OF STATION SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.	Sampled at
	THE AMERICAN AGRIC. CHEMICAL CO., N. Y.	
3326	Bradley's Alkaline Bone and Potash	Portland
3327	Bradley's Complete Manure for Potatoes and Vegetables	Portland
3510	Bradley's Complete Manure for Potatoes and Vegetables	Bangor
3328	Bradley's Complete Manure with 10% Potash	Portland
3511	Bradley's Complete Manure with 10% Potash	Bangor
3329	Bradley's Corn Phosphate	Portland
3330	Bradley's Eureka Fertilizer	Portland
3331	Bradley's Niagara Phosphate	Portland
3332	Bradley's Potato Fertilizer	Bangor
3333	Bradley's Potato Manure	Bangor
3334	Bradley's X L Superphosphate of Lime	Bangor
3512	Bradley's X L Superphosphate of Lime	Portland
3335	Clark's Cove Bay State Fertilizer	Bangor
3513	Clark's Cove Bay State Fertilizer	Portland
3336	Clark's Cove Bay State Fertilizer G. G	Bangor
3337	Clark's Cove Bay State Fertilizer for Seeding Down	Bangor
3514	Clark's Cove Bay State Fertilizer for Seeding Down	Portland
3338	Clark's Cove Defiance Complete Manure	Bangor
3339	Clark's Cove Great Planet Manure A A	Bangor
3515	Clark's Cove Great Planet Manure A A	Portland
3340	Clark's Cove King Philip Alkaline Guano	Bangor
3516	Clark's Cove King Philip Alkaline Guano	Portland
3341	Clark's Cove Potato Fertilizer	Portland
3342	Clark's Cove Potato Manure	Bangor
3343	Cleveland Fertilizer for All Crops	Bangor
3344	Cleveland High Grade Complete Manure	Bangor
3345	Cleveland Potato Phosphate	Bangor
3346	Cleveland Seeding Down Fertilizer	Bangor
3347	Cleveland Superphosphate	Bangor
3348	Complete Manure with 10% Potash	Houlton
3349	Crocker's Aroostook Potato Special	Bangor
3517	Crocker's Aroostook Potato Special	Portland
3350	Crocker's Ammoniated Corn Phosphate	Bangor
3518	Crocker's Ammoniated Corn Phosphate	Portland
3351	Crocker's Grass and Oats Fertilizer	Bangor
3519	Crocker's Grass and Oats Fertilizer	Portland
3352	Crocker's New Rival Ammoniated Superphosphate	Bangor
3520	Crocker's New Rival Ammoniated Superphosphate	Portland
3353	Crocker's Potato, Hop and Tobacco	Bangor
3521	Crocker's Potato, Hop and Tobacco	Portland
3354	Crocker's Special Potato Manure	Bangor
3522	Crocker's Special Potato Manure	Portland
3355	Cumberland Guano for All Crops	Bangor
3356	Cumberland Potato Fertilizer	Bangor
3357	Cumberland Seeding Down Manure	Bangor

ANALYSES OF STATION SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in Water.	Insoluble in Water.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3326	.....	.....	....	.....	6.60	3.25	2.08	9.85	11.00	11.93	12.00	2.16	2.00
3327	1.30	1.43	2.73	3.30	2.22	5.59	2.88	7.81	8.00	10.69	9.00	6.09	7.00
3510	1.81	1.69	3.40	3.30	3.72	4.41	3.19	8.13	8.00	11.32	9.00	7.31	7.00
3328	1.80	1.44	3.24	3.30	2.38	3.79	2.65	6.17	6.00	8.82	7.00	10.83	10.00
3511	0.78	2.52	3.30	3.30	3.56	3.47	4.13	7.03	6.00	11.16	7.00	11.21	10.00
3329	1.01	1.13	2.14	2.06	4.83	4.10	3.27	8.93	8.00	12.20	10.00	1.80	1.50
3330	0.63	0.51	1.14	1.03	5.14	3.20	1.90	8.34	8.00	10.24	10.00	2.23	2.00
3331	0.47	0.71	1.18	0.82	5.42	2.92	2.51	8.34	7.00	10.85	8.00	2.18	1.00
3332	0.67	1.55	2.22	2.06	5.71	2.22	3.55	7.93	8.00	11.48	10.00	3.66	3.00
3333	1.31	1.29	2.60	2.50	5.42	1.72	2.91	7.14	6.00	10.05	8.00	5.93	5.00
3334	0.97	1.29	2.26	2.50	7.24	1.94	2.62	9.18	9.00	11.80	11.00	2.24	2.00
3512	1.01	1.23	2.24	2.50	5.26	4.90	2.96	9.16	9.00	12.12	11.00	2.23	2.00
3335	0.93	1.51	2.44	2.50	5.77	2.64	2.74	8.41	9.00	11.15	11.00	2.45	2.00
3513	1.03	1.49	2.52	2.50	6.64	3.41	2.27	9.05	9.00	11.32	11.00	2.40	2.00
3336	0.93	1.39	2.32	2.06	5.74	2.32	2.55	8.06	8.00	10.61	10.00	1.71	1.50
3337	0.43	0.71	1.14	1.03	4.19	3.13	2.87	7.32	8.00	10.19	10.00	2.19	2.00
3514	0.77	0.43	1.20	1.03	4.31	5.86	2.32	10.17	8.00	12.49	10.00	2.19	2.00
3338	0.33	0.49	0.82	0.82	5.89	2.04	1.37	7.93	7.00	9.30	8.00	1.40	1.00
3339	1.33	2.09	3.42	3.30	4.19	3.40	3.02	7.59	8.00	10.61	9.00	7.77	7.00
3515	1.61	1.73	3.34	3.30	3.56	4.63	2.97	8.19	8.00	11.16	9.00	6.95	7.00
3340	0.43	0.65	1.08	1.03	4.83	3.09	2.54	7.92	8.00	10.46	10.00	2.11	2.00
3516	0.57	0.57	1.14	1.03	4.55	4.12	2.42	8.67	8.00	11.09	10.00	2.16	2.00
3341	0.99	0.95	1.94	2.06	5.30	2.78	2.93	8.08	8.00	11.01	10.00	3.17	3.00
3342	1.27	1.29	2.56	2.50	4.66	2.26	3.06	6.92	6.00	9.98	8.00	5.62	5.00
3343	0.55	0.53	1.08	1.03	5.10	2.67	2.09	7.96	8.00	10.05	10.00	2.09	2.00
3344	1.22	2.15	3.37	3.30	5.12	2.46	2.82	7.58	8.00	10.40	9.00	7.65	7.00
3345	0.55	1.55	2.10	2.06	6.06	2.41	1.80	8.47	8.00	10.27	10.00	3.02	3.00
3346	0.55	0.49	1.04	1.03	4.82	3.20	2.42	9.02	8.00	11.44	10.00	2.04	2.00
3347	0.81	1.27	2.08	2.06	3.40	4.58	2.23	7.98	8.00	10.21	10.00	1.81	1.50
3348	2.21	0.91	3.12	3.30	3.19	2.45	2.14	5.64	6.00	7.78	7.00	9.74	10.00
3349	1.06	0.87	1.93	2.06	5.71	1.75	2.99	7.46	8.00	10.45	......	6.11	6.00
3517	0.75	1.31	2.06	2.06	5.76	4.01	3.42	9.77	8.00	13.19	......	6.41	6.00
3350	1.05	0.85	1.90	2.06	3.96	5.06	2.14	9.02	8.00	11.16	.....	1.71	1.50
3518	1.45	0.93	2.38	2.06	4.47	3.17	3.89	7.64	8.00	11.55	....	1.93	1.50
3351	......	......	.....	.....	6.52	3.23	2.02	9.75	11.00	11.77	.....	2.12	2.00
3519	.....	....	....	.....	7.03	2.97	1.63	10.00	11.00	11.63	.....	2.27	2.00
3352	0.67	0.45	1.12	1.03	4.78	2.91	2.36	7.69	8.00	10.05	.....	1.97	2.00
3520	0.61	0.55	1.16	1.03	6.14	1.96	2.03	8.10	8.00	10.13	....	2.09	2.00
3353	0.67	1.41	2.08	2.06	5.82	1.76	2.42	7.58	8.00	10.00	.....	3.12	3.00
3521	0.69	1.07	1.76	2.06	4.47	3.04	3.10	7.51	8.00	10.61	.....	3.26	3.00
3354	0.63	2.61	3.24	3.29	3.70	1.93	4.55	5.63	6.00	10.18	.....	10.90	10.00
3522	0.74	1.59	2.33	3.29	4.08	4.25	2.60	8.33	6.00	10.93	.....	9.66	10.00
3355	0.65	0.49	1.14	1.03	5.26	2.74	1.94	8.00	8.00	9.94	10.00	2.15	2.00
3356	0.67	1.73	2.40	2.06	6.09	3.35	1.88	9.44	8.00	11.32	10.00	3.09	3.00
3357	0.43	0.83	1.26	1.03	5.18	3.47	2.79	8.65	8.00	11.44	10.00	2.09	2.00

DESCRIPTIVE LIST OF STATION SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.	Sampled at
3358	Cumberland Superphosphate	Bangor
3359	Darling's Blood, Bone and Potash	Houlton
3360	Great Eastern General Fertilizer	Bangor
3361	Great Eastern Grass and Oats Fertilizer	Bangor
3523	Great Eastern Grass and Oats Fertilizer	Portland
3362	Great Eastern High Grade Potato Manure	Bangor
3363	Great Eastern Northern Corn Special	Bangor
3364	Great Eastern Potato Manure	Bangor
3524	Great Eastern Potato Manure	Portland
3365	High Grade Fertilizer with 10% Potash	Houlton
3366	Lazaretto Aroostook Potato Guano	Bangor
3367	Lazaretto Corn Guano	Bangor
3368	Lazaretto High Grade Potato Guano	Bangor
3369	Lazaretto Propeller Potato Guano	Bangor
3370	Lazaretto Wheat, Oats and Clover Fertilizer	Bangor
3371	Otis' Potato Fertilizer	Skowhegan
3372	Otis' Seeding Down Fertilizer	Skowhegan
3373	Otis' Superphosphate	Skowhegan
3374	Pacific Dissolved Bone and Potash	Portland
3375	Pacific Grass and Grain Fertilizer	Portland
3525	Pacific Grass and Grain Fertilizer	Bangor
3376	Pacific High Grade General Fertilizer	Bangor
3377	Pacific Nobsque Guano	Bangor
3378	Pacific Potato Special	Bangor
3379	Packer's Union Animal Corn Fertilizer	Bangor
3526	Packer's Union Animal Corn Fertilizer	Portland
3380	Packer's Union Economical Vegetable Guano	Bangor
3381	Packer's Union Gardener's Complete Manure	Bangor
3382	Packer's Union Potato Manure	Bangor
3383	Packer's Union Universal Fertilizer	Bangor
3384	Packer's Union Wheat, Oats and Clover Fertilizer	Bangor
3385	Quinnipiac Climax Phosphate for All Crops	Bangor
3386	Quinnipiac Corn Manure	Bangor
3387	Quinnipiac Market Garden Manure	Houlton
3388	Quinnipiac Mohawk Fertilizer	Portland
3389	Quinnipiac Potato Manure	Bangor
3527	Quinnipiac Potato Manure	Portland
3390	Quinnipiac Potato Phosphate	Portland
3391	Quinnipiac Seeding Down Manure	Portland
3392	Read's Farmer's Friend	Portland
3528	Read's Farmer's Friend	Bangor
3393	Read's High Grade Farmer's Friend	Houlton
3394	Read's Potato Manure	Bangor
3395	Read's Practical Potato Special	Bangor
3396	Read's Standard Superphosphate	Bangor

ANALYSES OF STATION SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
%	%	%	%	%	%	%	%	%	%	%	%	%	%
3358	0.83	1.35	2.18	2.06	5.93	2.61	2.58	8.54	8.00	11.12	10.00	1.71	1.00
3359	2.38	1.45	3.83	4.10	3.64	3.57	2.36	7.21	7.00	9.57	8.00	7.53	7.00
3360	0.69	0.33	1.02	0.82	6.38	1.66	1.63	8.04	8.00	9.67	....	4.28	4.00
3361	......	.....	......	......	4.98	4.71	2.35	9.69	11.00	12.04	.....	2.31	2.00
3523	......	......	......	......	6.84	3.40	1.85	10.24	11.00	12.09	.....	2.28	2.00
3362	0.77	2.65	3.42	3.29	3.64	2 59	4.30	6.23	6.00	10.53	......	11.17	10.00
3363	1.05	1.25	2.30	2.06	5.95	2.11	2.87	8.06	8.00	10.93	......	1.82	1.50
3364	0.63	1.45	2.08	2.06	5.58	2.17	2.17	7.75	8.00	9.92	......	3.34	3.00
3524	0.64	0.98	1.62	2.06	4.16	5.38	2.74	9.54	8.00	12.28	.....	3.27	3.00
3365	1.17	1.29	2.46	2.40	3.48	3.74	2.49	7.22	6.00	9.71	7.00	10.18	10.00
3366	0.67	0.49	1.16	0.82	4.18	3.45	2.42	7.63	8.00	10.05	......	3.76	4.00
3367	1.17	0.67	1.84	1.64	4.55	3 08	3.06	7.63	8.00	10.69	....	2.11	2.00
3368	1.67	1.57	3.24	3.29	3.43	1.98	3.55	5.41	6.00	8.96	......	10.83	10.00
3369	1.05	0.91	1.96	2.06	5.58	2.73	2.93	8.31	8.00	11.24	......	5.88	6.00
3370	....	......	......	......	6.19	5.33	2.60	11.52	11.00	14.12	....	2.07	2.00
3371	1.05	1.09	2.14	2.06	4.85	2.75	2.93	7.60	8.00	10.53	10.00	3.03	3.00
3372	0.55	0.59	1.14	1.03	5.31	2.92	3.11	8.23	8.00	11.34	10.00	2.06	2.00
3373	1.07	1.13	2.20	2.06	3.72	6.23	2.30	9.95	8.00	12.25	10.00	1.72	1.50
3374	....	......	......	......	5.65	3.81	2.87	9.46	10.00	12.33	11.00	2.17	2.00
3375	0.33	0.79	1.12	0.82	2.81	3.94	3.06	6.75	7.00	9.81	8.00	1.00	1.00
3525	0.23	0.53	0.76	0.82	5.68	1.45	2.26	7.13	7.00	9.39	8.00	1.34	1.00
3376	2.27	1.57	3.84	3.30	3.59	4.39	2.59	7.98	8.00	9.67	9.00	6.49	7.00
3377	0.45	0.79	1.24	1.03	5.89	4.01	2.54	9.90	8.00	12.44	10.00	2.14	2.00
3378	1.22	0.79	2.01	2.06	4.91	3.65	3.48	8.56	8.00	12.04	10.09	3.28	3.00
3379	0.95	1.51	2.46	2.47	5.98	2.41	2.90	8.39	9.00	11.29	.....	2.32	2.00
3526	1.43	1.23	2.66	2.47	6.97	4.75	2.76	11.72	9.00	14.48	......	2.15	2.00
3380	0.71	0.55	1.26	1.25	4.86	2.46	2.49	7.32	6.00	9.81	...	3.71	3.00
3381	0.45	1.77	2.22	2.47	4.31	2.09	3.25	6.40	6.00	9.65	......	10.35	10.00
3382	0.75	1.25	2.00	2.06	6.22	2.53	2.70	8.75	8.00	11.45	....	6.07	6.00
3383	0.49	0.57	1.06	0.82	3.51	4.64	4.29	8.15	8.00	12.44	......	3.80	4.00
3384	.....	..	......	......	6.62	5.24	1.62	11.86	11.00	13.48	......	2.13	2.00
3385	0.76	0.67	1.43	1.03	5.02	3.32	1.96	8.34	8.00	10.30	10.00	2.78	2.00
3386	0.97	1.37	2.34	2.06	6.87	3.02	2.63	9.89	8.00	12.52	10.00	1.78	1.50
3387	1.68	1.39	3.07	3.30	3.96	3.70	2.50	7.66	8.00	10.16	9.00	6.48	7.00
3388	0.29	0.59	0.88	0.82	5.41	1.70	1.76	7.11	7.00	8.87	8.00	1.13	1.00
3389	1.23	1.23	2.46	2.50	5.30	1.29	3.04	6.59	6.00	9.82	8.00	5.48	5.00
3527	1.20	1.11	2.31	2.50	2.47	4.90	2.65	7.37	6.00	10.02	8.00	5.01	5.00
3390	1.23	0.83	2.06	2.06	4.74	3.24	4.24	7.98	8.00	12.22	10.00	2.82	3.00
3391	0.37	0.69	1.06	1.03	6.06	2.58	3.60	8.64	8.00	12.34	10.00	1.92	2.00
3392	0.77	1.47	2.24	2.06	6.76	1.04	2.70	8.70	8.00	11.40	10.00	2.82	3.00
3528	0.53	1.81	2.34	2.06	5.87	1.53	1.48	7.40	8.00	8.88	10.00	3.18	3.00
3393	2.21	0.91	3.12	3.30	3.19	2.45	2.14	5.64	6.00	7.78	7.00	9.74	10.00
3394	2.33	1.29	3.62	2.40	2.03	5.04	1.86	7.07	6.00	8 93	7.00	11.36	10.00
3395	0.69	0.29	0.98	0.82	2.09	2.86	3.22	4.95	4.00	8.17	5.00	10.04	8.00
3396	0.45	0.79	1.24	0.82	3.78	4.48	2.98	8.26	8.00	11.24	10.00	4.26	4.00

DESCRIPTIVE LIST OF STATION SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.	Sampled at
3397	Read's Sure Catch Fertilizer	Bangor
3398	Read's Vegetable and Vine Fertilizer	Bangor
3399	Soluble Pacific Guano	Portland
3400	Standard A Brand	Portland
3401	Standard Bone and Potash	Portland
3529	Standard Bone and Potash	Bangor
3402	Standard Complete Manure	Bangor
3403	Standard Fertilizer	Bangor
3404	Standard Guano for All Crops	Bangor
3405	Standard Special for Potatoes	Bangor
3406	Williams and Clark's Americus Ammo. Bone Superphosphate	Portland
3407	Williams and Clark's Americus Corn Phosphate	Portland
3530	Williams and Clark's Americus Corn Phosphate	Bangor
3408	Williams and Clark's Americus High Grade Special	Bangor
3409	Williams and Clark's Americus Potato Manure	Bangor
3531	Williams and Clark's Americus Potato Manure	Portland
3410	Williams and Clark's Americus with 10% Potash	Bangor
3411	Williams and Clark's Royal Bone Phosphate for All Crops	Portland
3412	High Grade Sulphate of Potash	Houlton
3413	Muriate of Potash	Portland
3414	Nitrate of Soda	Bangor
	THE BOWKER FERTILIZER CO., BOSTON, MASS.	
3415	Bowker's Bone and Potash Square Brand	Portland
3416	Bowker's Bone and Wood-Ash Fertilizer	Bangor
3417	Bowker's Bone, Blood and Potash	Houlton
3418	Bowker's Corn Phosphate	Portland
3532	Bowker's Corn Phosphate	Bangor
3419	Bowker's Early Potato Manure	Portland
3533	Bowker's Early Potato Manure	Bangor
3420	Bowker's Farm and Garden Phosphate	Portland
3534	Bowker's Farm and Garden Phosphate	Bangor
3421	Bowker's Fresh Ground Bone	Portland
3422	Bowker's Hill and Drill Phosphate	Portland
3535	Bowker's Hill and Drill Phosphate	Bangor
3423	Bowker's Market Garden Fertilizer	Bangor
3424	Bowker's Potash Bone	Bangor
3425	Bowker's Potash or Staple Phosphate	Bangor
3426	Bowker's Potato and Vegetable Fertilizer	Bangor
3536	Bowker's Potato and Vegetable Fertilizer	Portland
3427	Bowker's Potato and Vegetable Phosphate	Bangor
3537	Bowker's Potato and Vegetable Phosphate	Portland
3428	Bowker's Six Per Cent Fertilizer	Bangor
3429	Bowker's Superphosphate with Potash for Grass and Grain	Bangor
3430	Bowker's Sure Crop Phosphate	Portland
3431	Bowker's Ten Per Cent Manure	Bangor
3432	Stockbridge Corn and Grain Manure	Portland

ANALYSES OF STATION SAMPLES, 1904.

Station number.	Nitrogen. Soluble in water.	Nitrogen. Insoluble in water.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3397	....	....	....	....	7.13	3.37	1.45	10.50	10.00	11.95	11.00	2.21	2.00
3398	0.97	0.97	1.94	2.06	5.42	2.80	2.93	8.22	8.00	11.15	10.00	6.45	6.00
3399	1.09	1.07	2.16	2.06	4.23	3.63	3.50	7.86	8.00	11.36	10.00	1.80	1.50
3400	0.61	0.53	1.14	0.82	5.26	2.74	2.32	8.00	7.00	10.32	8.00	2.20	1.00
3401	....	....	....	....	6.43	3.10	2.58	9.53	10.00	12.11	11.00	2.13	2.00
3529	....	....	....	....	6.84	3.21	1.67	10.05	10.00	11.72	11.00	2.28	2.00
3402	0.08	2.15	2.23	3.30	4.55	4.09	3.69	8.64	8.00	12.33	9.00	7.27	7.00
3403	1.13	1.01	2.14	2.06	5.69	2.75	3.57	8.44	8.00	12.01	10.00	1.86	1.50
3404	0.53	0.59	1.12	1.03	4.77	4.06	2.30	8.83	8.00	11.13	10.00	2.18	2.00
3405	0.71	1.59	2.30	2.06	6.06	2.95	2.11	9.01	8.00	11.12	10.00	3.16	3.00
3406	1.57	0.97	2.54	2.50	8.10	2.96	2.07	11.06	9.00	13.13	11.00	2.11	2.00
3407	1.23	1.15	2.38	2.06	4.27	3.58	3.16	7.85	8.00	11.01	10.00	1.73	1.50
3530	1.11	0.81	1.92	2.06	4.80	4.25	2.59	9.05	8.00	11.64	10.00	1.61	1.50
3408	0.91	1.95	2.86	3.30	4.10	3.34	3.13	7.44	8.00	10.57	9.00	6.40	7.00
3409	1.19	0.91	2.10	2.06	3.35	4.58	3.16	7.93	8.00	11.09	10.00	3.47	3.00
3531	0.55	1.63	2.18	2.06	6.14	2.47	1.53	8.61	8.00	10.14	10.00	3.03	3.00
3410	1.51	1.79	3.30	2.40	4.75	1.30	2.96	6.05	6.00	9.01	7.00	10.02	10.00
3411	0.55	0.65	1.20	1.03	6.06	1.88	2.51	7.94	8.00	10.45	10.00	2.41	2.00
3412	....	....	....	....	....	....	....	....	....	....	....	46.00	48.00
3413	....	....	....	....	....	....	....	....	....	....	....	49.64	50.00
3414	15.28	0.00	15.28	15.00	....	....	....	....	....	....	....	....	....
3415	0.73	1.15	1.88	1.65	5.50	3.94	2.78	9.44	6.00	12.22	7.00	2.09	2.00
3416	0.65	1.05	1.70	1.65	3.86	3.22	3.33	7.08	8.00	10.41	8.00	2.14	2.00
3417	1.55	2.61	4.16	4.10	7.08	1.78	1.12	8.86	8.00	10.08	10.00	7.07	7.00
3418	0.91	0.65	1.56	1.65	4.88	2.08	3.36	6.96	8.00	10.32	9.00	2.27	2.00
3532	1.28	1.04	2.32	1.65	4.59	3.79	3.47	8.38	8.00	11.85	9.00	1.80	2.00
3419	1.83	1.25	3.08	3.29	3.54	4.24	2.67	7.78	7.00	10.45	8.00	6.37	7.00
3533	1.29	2.15	3.44	3.29	3.67	3.13	3.14	6.80	7.00	9.94	8.00	7.26	7.00
3420	0.85	0.75	1.60	1.65	4.83	2.23	3.39	7.06	8.00	10.45	9.00	2.13	2.00
3534	0.92	1.04	1.96	1.65	5.55	2.45	2.45	8.00	8.00	10.45	9.00	2.25	2.00
3421	....	....	2.74	2.47	....	....	....	....	....	23.72	18.00	....	....
3422	0.97	1.29	2.26	2.47	4.00	4.78	3.01	8.78	9.00	11.80	10.00	2.15	2.00
3535	1.09	1.15	2.24	2.47	7.24	2.09	2.19	9.33	9.00	11.52	10.00	2.22	2.00
3423	0.43	1.77	2.20	2.47	6.92	0.21	3.32	7.13	6.00	10.45	7.00	10.39	10.00
3424	0.29	0.71	1.00	0.82	5.60	1.82	1.48	7.42	6.00	8.90	7.00	2.08	2.00
3425	0.42	0.41	0.83	0.82	3.22	4.56	3.02	7.78	8.00	10.80	9.00	2.85	3.00
3426	1.11	1.37	2.48	2.47	3.11	3.62	3.01	6.73	8.00	9.84	10.00	3.93	4.00
3536	1.27	1.19	2.46	2.47	7.08	3.27	1.98	10.25	8.00	12.33	10.00	4.51	4.00
3427	0.76	0.79	1.55	1.65	3.22	5.01	2.73	8.23	9.00	10.96	10.00	1.81	2.00
3537	0.89	0.67	1.56	1.64	4.71	2.89	3.36	7.60	9.00	11.96	10.00	2.25	2.00
3428	0.63	0.45	1.08	0.82	4.21	3.26	2.00	7.47	6.00	9.47	7.00	6.48	6.00
3429	....	....	....	....	6.06	3.67	2.26	9.73	10.00	11.99	11.00	2.25	2.00
3430	0.47	0.07	1.14	0.82	3.05	7.10	3.73	10.15	9.00	13.88	10.00	2.07	2.00
3431	0.28	0.43	0.71	0.82	1.00	5.53	2.88	6.53	5.00	9.41	6.00	9.50	10.00
3432	1.47	1.77	3.24	3.29	3.80	3.78	3.15	7.58	7.00	10.73	8.00	7.03	7.00

DESCRIPTIVE LIST OF STATION SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.	Sampled at
3433	Stockbridge Potato Manure	Portland
3434	Stockbridge Seeding Down Manure	Bangor
3435	Monticello Grange Chemicals	Houlton
3436	Special Potato Manure for the Grange	Houlton
	E. FRANK COE CO., NEW YORK CITY, N. Y.	
3437	E. Frank Coe's Celebrated Special Potato Fertilizer	Bangor
3438	E. Frank Coe's Columbian Bone Superphosphate	Portland
3439	E. Frank Coe's Columbian Corn Fertilizer	Bangor
3440	E. Frank Coe's Columbian Potato Fertilizer	Bangor
3441	E. Frank Coe's Excelsior Potato Fertilizer	Bangor
3442	E. Frank Coe's Grass and Grain Fertilizer	Bangor
3443	E. Frank Coe's High Grade Ammoniated Bone Superphosphate	Bangor
3444	E. Frank Coe's High Grade Potato Fertilizer	Bangor
3445	E. Frank Coe's New England Corn Fertilizer	Bangor
3446	E. Frank Coe's New Englander Potato Fertilizer	Bangor
3447	E. Frank Coe's Prize Brand Grain and Grass Fertilizer	Bangor
3448	E. Frank Coe's Red Brand Excelsior Guano	Bangor
3538	E. Frank Coe's Red Brand Excelsior Guano	Portland
3449	E. Frank Coe's Standard Grade Ammo. Bone Superphosphate	Bangor
	JOHN WATSON CO., HOULTON, ME.	
3450	Watson's Improved High Grade Potato Manure	Houlton
	LISTER'S AGRICUL. CHEM. WORKS, NEWARK, N. J.	
3451	Lister's Animal Bone and Potash	Portland
3539	Lister's Animal Bone and Potash	Bangor
3452	Lister's High Grade Special for Spring Crops	Portland
3453	Lister's Oneida Special	Portland
3454	Lister's Potato Manure	Portland
3540	Lister's Potato Manure	Bangor
3455	Lister's Pure Raw Bone Meal	Bangor
3456	Lister's Special Corn Fertilizer	Portland
3457	Lister's Special Potato Fertilizer	Portland
3458	Lister's Success Fertilizer	Portland
	NATIONAL FERTILIZER CO., BRIDGEPORT, CONN.	
3459	Chittenden's Ammoniated Bone Phosphate	Presque Isle
3460	Chittenden's Complete Root	Houlton
3461	Chittenden's Market Garden	Houlton
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.	
3462	New England Corn and Grain Fertilizer	Bangor
3463	New England Corn Phosphate	Bangor
3541	New England Corn Phosphate	Portland
3464	New England High Grade Potato Fertilizer	Bangor
3465	New England Potato Fertilizer	Bangor
3466	New England Superphosphate	Bangor
3542	New England Superphosphate	Portland
	THE PARMENTER & PALSEY FERT. CO., PEABODY, MASS.	
3467	A. A. Brand Fertilizer	Presque Isle
3468	Aroostook Special Brand	Presque Isle
3469	Grain Grower Brand	Old Town
3471	P. & P. Potato Brand	Presque Isle
3472	Plymouth Rock Brand	Presque Isle
3473	Special Potato Brand	Presque Isle
3474	Star Brand Superphosphate	Bangor

ANALYSES OF STATION SAMPLES, 1904.

Station number.	Nitrogen. Soluble in water.	Nitrogen. Insoluble in water.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3433	1.53	1.63	3.16	3.29	2.23	3.86	2.09	6.09	6.00	8.18	7.00	9.58	10.00
3434	0.71	1.67	2.38	2.47	4.26	3.80	1.90	7.06	6.00	8.96	9.00	10.62	10.00
3435	1.07	1.51	2.58	2.50	6.95	1.57	1.77	8.52	8.00	10.29	12.00	4.29	4.00
3436	0.63	0.71	1.34	1.50	4.26	5.91	1.59	10.17	9.00	11.76	12.00	13.35	12.00
3437	0.83	0.93	1.76	1.65	6.59	3.41	1.68	10.00	8.00	11.68	9.50	4.92	4.00
3438	0.77	0.83	1.60	1.20	8.72	1.49	1.29	10.21	8.50	11.50	10.50	2.63	2.50
3439	0.61	0.79	1.40	1.23	7.51	2.23	1.48	9.74	8.50	11.32	10.50	2.70	2.50
3440	0.53	0.88	1.36	1.23	7.89	1.99	1.28	9.88	8.50	11.16	10.50	2.56	2.50
3441	1.46	0.69	2.15	2.50	6.41	1.75	1.68	8.16	7.00	9.84	9.00	7.43	8.00
3442	0.76	1.01	1.77	0.80	7.66	1.13	2.95	8.79	8.50	11.74	10.00	2.61	1.50
3443	1.63	0.77	2.40	1.85	9.23	1.35	1.86	10.58	9.00	12.44	13.00	2.57	2.25
3444	1.99	0.79	2.78	2.40	6.62	1.75	1.61	8.37	7.50	9.98	....	6.18	6.00
3445	0.35	0.69	1.04	0.80	7.00	2.18	1.35	9.18	7.50	10.53	8.50	3.21	3.00
3446	0.35	0.69	1.04	0.80	7.62	1.40	1.71	9.02	7.50	10.73	8.50	3.10	3.00
3447	......	......	....	....	7.15	2.86	4.43	10.01	10.50	14.44	12.00	3.31	2.00
3448	2.44	0.89	3.33	3.40	7.89	3.01	1.33	10.90	9.00	12.23	11.00	6.24	6.00
3538	2.23	1.09	3.32	3.40	8.26	2.21	1.17	10.47	9.00	11.64	11.00	5.98	6.00
3449	0.59	0.71	1.30	1.20	6.78	3.18	1.91	9.96	8.50	11.87	10.00	2.26	2.00
3450	1.89	1.17	3.06	3.00	4.15	1.73	1.03	5.88	6.00	6.91	9.00	5.23	5.00
3451	.....	......	......	......	5.34	3.25	2.78	9.41	10.00	12.19	....	2.24	2.00
3539	.....	......	......	......	6.01	4.87	1.75	10.88	10.00	12.63	.....	2.27	2.00
3452	0.73	0.99	1.72	1.65	3.21	5.24	2.48	8.45	8.00	10.93	10.00	9.70	10.00
3453	0.53	0.57	1.10	0.82	2.93	4.32	1.38	7.25	7.00	8.63	8.00	1.43	1.00
3454	2.11	1.19	3.30	3.30	3.83	3.36	2.67	7.19	8.06	9.86	9.00	7.68	7.00
3540	0.90	1.78	2.68	3.30	4.15	3.16	3.14	7.31	8.00	10.45	9.00	6.88	7.00
3455	.....	....	2.37	2.68	.....	......	......	.....	......	22.11	23.00	....	.....
3456	0.71	1.21	1.92	1.65	5.84	2.85	2.16	8.69	8.00	10.85	9.00	3.18	3.00
3457	0.11	0.83	1.94	1.65	5.77	3.01	2.42	8.78	8.00	11.20	9.00	3.29	3.00
3458	0.51	0.87	1.38	1.24	6.14	2.93	2.25	9.07	9.00	11.32	11.00	2.23	2.00
3459	1.44	1.29	1.73	1.70	4.61	6.68	0.88	11.29	8.00	12.17	10.00	2.51	2.00
3460	1.46	1.79	3.25	3.30	6.86	3.42	1.98	9.17	8.00	11.15	10.00	6.62	6.00
3461	1.53	1.15	2.68	2.40	4.86	1.30	1.62	6.16	6.00	7.78	8.00	5.20	5.00
3462	0.63	0.73	1.36	1.22	5.26	1.81	0.87	7.07	7.00	7.94	8.00	2.21	2.00
3463	0.54	0.97	1.51	1.64	5.66	1.09	2.78	5.75	8.00	8.53	9.00	2.93	3.00
3541	0.79	0.83	1.62	1.64	3.29	4.96	2.02	8.25	8.00	10.27	9.00	3.17	3.00
3464	1.41	1.09	2.50	2.46	4.94	4.45	2.05	9.43	8.00	11.48	9.00	6.16	6.00
3465	0.99	0.97	1.96	1.64	6.30	1.26	0.73	7.56	7.00	8.29	8.00	4.15	4.00
3466	1.29	0.97	2.26	2.46	4.51	4.46	1.98	8.97	9.00	10.96	10.00	4.20	4.00
3542	1.04	1.18	2.22	2.46	6.86	2.90	1.45	9.76	9.00	11.21	10.00	4.23	4.00
3467	2.28	1.25	3.53	4.10	2.23	5.82	1.06	8.05	7.00	9.11	8.00	8.80	8.00
3468	3.19	0.71	3.90	3.70	3.99	2.94	1.44	6.93	7.00	8.37	8.00	9.95	10.00
3469	0.35	0.63	0.98	0.82	3.56	1.54	2.90	5.10	7.00	8.05	8.00	2.00	2.00
3471	0.91	0.91	1.82	1.64	2.07	3.17	4.31	5.24	6.00	9.55	7.00	6.10	6.00
3472	1.31	0.95	2.26	2.47	1.91	6.73	3.39	8.64	8.00	12.03	9.00	4.31	4.00
3473	2.17	0.95	3.12	3.29	3.47	4.13	1.61	7.61	8.00	9.22	9.00	7.27	7.00
3474	0.67	0.81	1.48	1.64	2.06	4.63	3.53	6.69	7.00	10.22	8.00	2.24	2.50

DESCRIPTIVE LIST OF STATION SAMPLES, 1904.

Station number.	Manufacturer, place of business and brand.	Sampled at
	PORTLAND RENDERING CO., PORTLAND, ME.	
3475	Bone Tankage	East Deering
	PROVINCIAL CHEM. FER. CO., LIMITED, ST. JOHN, N. B.	
3476	Potato Phosphate	Caribou
3543	Potato Phosphate	Fort Fairfield
	RUSSIA CEMENT CO., GLOUCESTER, MASS.	
3477	Essex A1 Superphosphate	Caribou
3478	Essex Complete Manure for Corn, Grain and Grass	Bangor
3479	Essex Complete Manure for Potatoes, Roots and Vegetables	Caribou
3480	Essex Corn Fertilizer	Bangor
3481	Essex Market Garden and Potato Manure	Caribou
3482	Essex XXX Fish and Potash	Presque Isle
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.	
3483	Aroostook Potato Manure	Bowdoinham
3484	Dirigo Fertilizer	Bowdoinham
3485	Sagadahoc High Grade Superphosphate	Bowdoinham
3486	Sagadahoc Special Potato Fertilizer	Bowdoinham
3487	Special Clover Fertilizer	Bowdoinham
3488	XX Chemicals	Bowdoinham
3489	Yankee Fertilizer	Bowdoinham
3490	Acid Phosphate	Bowdoinham
3491	Muriate of Potash	Bowdoinham
3492	Nitrate of Soda	Bowdoinham
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.	
3497	Swift's Lowell Animal Brand	Portland
3544	Swift's Lowell Animal Brand	Bangor
3498	Swift's Lowell Bone Fertilizer	Portland
3545	Swift's Lowell Bone Fertilizer	Bangor
3499	Swift's Lowell Cereal Fertilizer	Portland
3546	Swift's Lowell Cereal Fertilizer	Bangor
3500	Swift's Lowell Dissolved Bone and Potash	Portland
3547	Swift's Lowell Dissolved Bone and Potash	Bangor
3501	Swift's Lowell Empress Brand	Portland
3503	Swift's Lowell Potato Manure	Portland
3548	Swift's Lowell Potato Manure	Bangor
3504	Swift's Lowell Potato Phosphate	Portland
3549	Swift's Lowell Potato Phosphate	Bangor

ANALYSES OF STATION SAMPLES, 1904.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
3475	0.68	4.20	4.88	5.30	......	....	12.06	4.21	7.00	16.27	15.00	.....	....
3476	0.57	1.15	1.72	1.23	6.03	2.18	5.04	8.21	8.00	13.25	......	6.01	6.50
3543	0.57	1.07	1.64	1.23	6.06	2.65	5.82	8.71	8.00	14.53	...	6.02	6.50
3477	....	1.32	1.32	1.00	2.11	7.84	3.50	9.95	7.00	13.45	9.00	1.85	2.00
3478	0.97	2.25	3.22	3.30	3.94	4.12	5.31	9.06	7.00	13.37	9.50	10.58	9.50
3479	0.99	2.81	3.80	3.70	5.82	4.70	3.96	10.52	7.00	14.48	9.00	8.22	8.50
3480	0.49	1.69	2.18	2.00	3.64	4.61	3.89	8.25	8.50	12.14	10.50	3.15	3.00
3481	0.65	1.61	2.26	2.00	4.43	3.56	4.53	7.99	8.00	12.52	10.00	5.28	5.00
3482	0.67	1.71	2.38	2.10	3.81	4.18	5.63	7.99	9 00	13.62	12.10	2.28	2.25
3483	1.11	0.27	1.38	1.10	5.53	0.41	3.33	5.94	6.00	9.27	7.00	4.27	4.00
3484	0.05	0.62	0.67	1.25	6.22	3.90	2.64	10.12	6.00	12.76	10.00	5.32	2.00
3485	0.99	0.65	1.64	2.00	6.52	6.05	1.50	12.57	6.00	14.07	7.00	6.56	3.0
3486	1.45	0.33	1.78	2.25	7.10	0.35	2.42	7.45	7.00	9.87	8.00	8.57	8.00
3487	0.35	0.39	0.74	0.85	3.21	5.68	1.40	8.89	7.00	10.29	8.00	.....	......
3488	6.27	1.15	7.42	7.00	.....	.....	3.93	4.27	......	8.20	7.00	9.35	8.00
3489	0.49	0.17	0.66	0.40	6.71	2.51	1.72	9.22	7.00	10.94	8.00	2.98	2.00
3490	....	......	......	.....	11.67	5.05	0.51	16.72	15.00	17.23	17.00	....	.....
3491	.....	.....	....	....	......	.....	.....	.....	.....	......	.....	50.04	57.00
3492	15.20	....	15.20	15.00	.....	.....	.....	......	......	15.20	.....	......	.....
3497	1.22	1.13	2.35	2.46	6.62	2.42	1.81	9.04	9.00	10.85	10.00	4.35	4.00
3544	1.11	1.31	2.42	2.46	4.93	5.16	2.18	10.09	9.00	12.27	10.00	4.10	4.00
3498	0.75	0.79	1.54	1.64	4.15	2.96	2.14	7.11	8.00	9.25	9.00	3.00	3.00
3545	0.81	0.87	1.68	1.64	4.78	4.00	1.79	8.78	8.00	10.57	9.00	3.07	3.00
3499	0.13	0.69	0.82	0.81	2.55	2.13	1.14	4.68	7.00	5.82	8.09	1.32	1.00
3546	0.17	0.61	0.78	0.81	5.02	2.66	0.66	7.68	7.00	8.34	8.00	1.27	1.00
3500	0.47	1.17	1.64	1.64	6.69	1.60	1.28	8.29	9.00	9.57	10.00	2.37	2.00
3547	0.61	1.11	1.72	1.64	6.03	3.95	2.21	9.98	9.00	12.19	10.00	1.98	2.07
3501	0.24	0.55	0.79	1.23	5.74	1.11	0.45	6.85	7.00	7.30	10.00	2.06	2.00
3503	0.54	0.97	1.51	1.64	3.60	2.93	1.40	6.53	7.00	7.93	8.00	4.07	4.00
3548	0.95	1.11	2.06	1.64	4.18	3.93	2.18	8.11	7.00	10.29	8.00	3.85	4.00
3504	1.45	1.11	2.56	2.46	4.94	2.52	1.95	7.46	8.00	9.41	9.00	6.15	6.00
3549	1.19	1.11	2.30	2.46	4.48	4.26	2.11	8.74	8.00	10.85	9.00	6.28	6.00

[Continued from page 101.]

should appear when one considers that the comparison is made with the manufacturers' minimum guarantees. In the case of the company which puts the largest number of brands on the market, 45 per cent of the samples analyzed were below the guarantee in one or more of the fertilizing ingredients. With another large company putting twenty-two brands on the market, 57 per cent of the samples examined were also below the guarantee in at least one constituent. In the case of still another company, only four of the fourteen samples examined were found below the guarantee, and the differences in these samples were insignificant. The results on the remaining samples were uniformly above the guarantees, showing that the goods were well mixed. The other companies, putting a less number of brands upon the market, for the most part make no better showing, the results of the analyses being variable.

Most of the companies keep up the practice of giving an elastic guarantee, as for instance, one finds printed on the package: Nitrogen, 3 to 4 per cent. Available phosphoric acid, 6 to 8 per cent. Potash, 4 to 5 per cent. One might expect goods with such guarantees to average 3 1-2, 6 1-2 and 4 1-2 per cent, but legally the company could be holden for only the minimum figures. An inspection of the tables this year would seem to indicate that the minimum figures are all they are working for and the maximum ones should no longer be printed.

Such wide variations as are given in some instances indicate one of two things, carelessness in methods of manufacture, or inability to make goods of uniform composition. If the manufacturer with all his knowledge of the materials used and improved machinery at his command cannot make goods of more uniform composition than some of those here reported upon, then he can do no better at mixing than the farmer with a shovel on the barn floor, and thorough mixing can no longer be urged as an argument for buying mixed goods.

SOY BEANS IN MAINE.

CHAS. D. WOODS and J. M. BARTLETT.

The soy bean was introduced into the United States several years ago from Japan, where it is grown for human food. In this country it has chiefly been grown as a forage crop, and as it thrives best in a moderately warm climate is better known in the southern and middle than in the northern states. Some of the earlier varieties, however, will mature seed in New England. At the Massachusetts and Storrs (Conn.) Experiment Stations a few varieties have been grown quite successfully for soiling crops, for silage by itself or mixed with corn, and for the seeds. Farmers' bulletin No. 58 of the United States Department of Agriculture summarizes the present status of the soy bean as a forage crop. Because of numerous inquiries, the Maine station has experimented somewhat with this crop. The results of these experiments are here reported and there is also included such deductions and citations from Farmers' Bulletin 58 and the publications of the Massachusetts and Storrs stations as seem adapted to Maine climate and conditions.

THE PLANT.

"The soy bean is an erect, annual plant, with branching, hairy stem, trifoliate, more or less hairy leaves, rather inconspicuous pale lilac or violet colored flowers, and broad, two to five-seeded pods, covered like the stem, with stiff, reddish hairs. The seeds vary in color from whitish and yellowish to green, brown and black; and in shape from spherical to elliptical and more or less compressed." *

The seeds are self pollinated and on this account are sure to produce seeds wherever the plants reach maturity.

* Farmers' Bulletin 58, U. S. Dept. of Agr.

VARIETIES.

There are numerous quite distinct varieties of the soy bean, only the earliest of which can be grown in Maine. The early white soy bean is the best variety for seed with us. It is not a good variety, however, for soiling or silage on account of its small size, while its tendency to drop its leaves early unfits it for hay. Plants of this variety matured seed at Orono in 1904. The medium early green is one of the best for Maine as it yields heavily and retains its leaves well. This last is an important feature if it is planned to make hay from the crop. The medium early black is the favorite in the central states.

In 1903 and 1904 the Station grew several varieties of soy beans from seed furnished by the United States Department of Agriculture. The early white soy bean matured and the medium early green and black varieties formed pods. The Henderson Early, (a medium early green), purchased from Peter Henderson Company, New York, was as satisfactory as any grown, both in earliness and yield.

CONDITIONS OF GROWTH.

"It is believed in Japan that in northern climates, soils of a rather strong character are best adapted to the soy bean. It is usually sown about the end of May, and when used for hay is cut early in August. In both Europe and America it has been found to thrive best on soils of medium texture that are well supplied with potash, phosphoric acid, and lime. It succeeds very well, however, on comparatively light soils, often giving an abundant crop on soils too poor to grow clover." *

The soy bean requires about the same temperature as corn. Professor Brooks says that the earlier sorts will mature in Massachusetts with as much certainty as will the earlier varieties of corn.

As a general thing, the soy bean is not so easily injured by frost as the common field or garden varieties of beans, and hence it can be planted earlier in the spring and can also be left in the field later in the autumn.

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* Farmers' Bulletin 58, U. S. Dept. of Agr.

FERTILIZING AND CULTURE.

Like all leguminous plants, the soy bean, through the aid of root tubercle organisms, acquires atmospheric nitrogen. When the soy bean was first introduced into America it did not form root tubercles. In order to insure the growth of the root tubercles it is necessary to use seed that has been inoculated, or to inoculate the soil with the proper organism. This last is readily done by applying broadcast a small amount of soil taken from a field where soy beans developing root tubercles have been grown. At this Station no tubercles formed on plants grown in soil that had not been inoculated, but they grew abundantly where soil from infested soy bean was applied at the rate of a few barrels to the acre. According to our experience the beans will grow as well without the root tubercles as with, provided they are liberally fertilized. Their economical growth depends upon the presence of the root tubercles, as in this way they can be grown with little or no nitrogen in the fertilizer. If they are to be grown on soil containing no root tubercle organisms, they require a fairly liberal application of a complete fertilizer. If grown in good soil where root tubercles may be expected to develop, only phosphoric acid and potash need be supplied in the fertilizer. The soil should be prepared as for ordinary beans. It should be made fine, free from clods and lumps, and smooth. A good seed bed is essential to a good growth.

In this climate the soy bean should be planted a little earlier than ordinary beans, but not until the ground has warmed up considerably. The first season we planted in drills 3 feet apart. This was too far apart for the best yield. Nearly double the yield per acre is obtained when the drills are 16 inches apart. In the case of the wide drills it was necessary to cultivate three times with the horse cultivator. With the drills 16 inches apart they were cultivated once with a hand wheel hoe. On fairly clean land good success may be had with broadcasting or still better by the use of the grain drill. If planted in rows, the seed should be sown with a hand seed drill similar to that used for beets or turnips. It will require about 3 pecks of seed per acre of the medium green soy bean when seeded in drills 16 inches apart. If the seed is broadcast, a bushel will be none too much for an acre. It will probably not be wise to attempt to grow soy beans in Maine for the seed, but if this is done, the drills

should be at least 20 inches apart and the soil should be kept stirred and clean, as in the case of ordinary field beans. If wanted for silage, the beans can be grown alone or planted with corn. The latter method is quite strongly recommended, the seeds being mixed and put in the planter in the proportion of 10 quarts of corn to 7 of beans. The forage from this mixture can be fed green or cut for the silo.

HARVESTING.

From analyses made at the South Carolina Experiment Station it appears that the dry matter carries relatively about the same percentages of protein and fat when the pods are just forming as they do when the pods are well developed. The stalk carries a large amount of crude fiber, and on this account the leaves are the most important part of the green plant for feeding. The yield will be somewhat greater near maturity but when digestibility and palatability are considered, cutting as soon as the pods form is probably better. From our experiments, plants will be ready to cut with corn for silage if the seed is planted about June 10.

If the crop is to be used for soiling, cutting can begin when the plants are in early bloom and can be kept up in this climate until frost. The soy bean is a coarse growing plant and cures slowly, and on this account it is doubtful if it should ever be grown in Maine to be cured as hay. Cock curing is the most practical method, but will be likely to prove unsatisfactory. For the silo the harvesting can be delayed as long as it is prudent to allow corn to stand in the field. A grain reaper and binder can be used to advantage in harvesting this crop for the silo. If in drills 16 inches apart, 3 or 4 rows can be cut at once. A mowing machine can be used to cut the crop, but it will not handle as well for the silage cutter as when in bundles.

In harvesting a crop for seed, it can be cut before the pods are mature. If the pods become too ripe (in this climate there is little danger of this, however,) before harvesting, they are liable to burst and shell and thus part of the seed be lost. In harvesting for seed the crop can be pulled by hand, or cut by hand or machine. It will be quickest cured if put in piles that are relatively high and narrow. Threshing can be by hand or machine.

YIELD.

The yield of green fodder that can be had in Maine will probably vary from 5 to 10 tons per acre. In the large plots grown by this Station in 1903 the largest yield was only a little over 5 tons to the acre. But the rows were twice too far apart, having been planted in drills 3 feet apart. If they had been planted at the same distance as the small plots in 1904 (16 inches) there is no reason for thinking the yield would not have been nearly or quite doubled, for at no time did the plants come near filling the space between the rows. On good land, with fair cultivation and average season, a yield of 8 tons of green fodder could doubtless be counted upon. Cured into hay this would give a yield of about 2½ tons per acre.

NUTRIENTS IN SOY BEAN AND THEIR DIGESTIBILITY.

In the Farmers' Bulletin previously cited, tables arranged with great care showing the chemical composition of the various parts of the soy bean and their digestibility are given. These tables are quoted in the tables on pages 118 and 119 and to them are added the results of analyses and digestion experiments made at this Station with soy bean and corn.

The composition of the soy bean as compared with other legumes stands high. The fodder closely resembles clover in composition and soy bean silage, in both composition and digestibility, is the equal of clover silage. It is doubtful if any more digestible nutrients can be grown from an acre with soy beans than with clover. But in some localities they are a surer crop and need only a single season for their growth. Soy beans would be more naturally compared in this State with corn, for if grown at all they seem best adapted for silage. The chief difference between corn and soy beans is found in the high protein content of the latter. Like other beans it has the power of taking its nitrogen to form protein from the air, and since it is richer in protein than corn, it may be justly considered a desirable addition to the list of forage plants. As the price of feeds rich in protein is advancing it seems very desirable that as many legumes (plants rich in protein) that can gather their own nitrogen from the air be grown as possible.

CHEMICAL COMPOSITION OF SOY BEAN AND CORN FORAGE AND SILAGE.

Forage.	Number of analyses.	Fresh or Air-dry Substance.						Water-free Substance.				
		Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
Early bloom to seed[1]	13	76.5	2.3	3.6	6.5	10.1	1.0	10.0	15.3	27.6	43.0	4.1
Whole plant, pod just forming[8]	1	73.2	2.0	3.0	4.9	15.9	0.9	7.7	11.0	18.5	59.4	3.4
Corn fodder[8]	13	78.9	1.3	2.3	4.2	12.7	0.6	6.1	10.8	19.8	60.3	2.9
Soy bean hay (Jap.)	1	16.0	5.9	16.9	35.9	23.1	2.2	7.0	20.1	42.7	27.5	2.6
Soy bean hay (Mass.)[2]	4	12.1	7.3	14.2	21.1	41.2	4.1	....	16.2	24.0	46.8	4.7
Soy bean straw (Mass.)[2]	3	11.4	6.4	4.9	37.6	37.8	1.9	....	5.5	42.4	42.7	2.2
Soy bean straw, hulls and vines after threshing[3]	1	5.7	3.9	4.0	49.5	36.0	0.8	5.3	4.25	52.6	38.2	0.85
Soy bean seed[4]	8	10.8	4.7	34.0	4.8	28.8	16.9	5.3	38.1	5.4	32.2	18.9
Soy bean meal[5]	2	10.4	5.1	36.0	2.6	27.0	18.9	5.7	40.2	2.9	30.2	21.0
Soy bean silage[6]	1	74.2	2.8	4.1	9.7	7.0	2.2	11.0	15.7	37.6	27.0	8.7
Corn and soy bean silage[7]	4	76.0	2.4	2.5	7.2	11.1	0.8	....	10.4	30.0	46.3	3.3
Corn and soy bean silage[8]	1	79.8	1.2	2.1	5.1	11.1	0.7	5.8	10.5	25.2	55.3	3.2
Mature corn silage	1	79.6	1.0	2.1	4.7	11.8	0.8	4.8	10.2	23.1	57.9	4.0
Immature corn silage	4	79.7	1.0	1.5	5.1	11.8	0.8	4.9	7.4	25.7	59.0	3.0
Millet and soy bean silage[7]	9	79.0	2.8	2.8	7.2	7.2	1.0	....	13.3	34.3	34.3	4.8

[1] Ninth An. Rep. Storrs Exp. Sta., pp. 281, 285 (1896).
[2] Eighth An. Rep. Mass. Hatch. Sta., p. 87 (1896).
[3] Second An. Rep. S. C. Exp. Sta., p. 179 (1890).
[4] Bull. 15 U. S. Dept. Agric., Office Exp. Stations, p. 390 (1893).
[5] Eighth An. Rep. Storrs Exp. Sta., pp. 183, 186 (1895).
[6] Bull. Tenn. Exp. Sta., Vol. IX, No. 3, p. 106 (1896).
[7] Ninth An. Rep. Mass. Hatch. Sta., p. 140 (1897).
[8] Maine Station, unpublished results.

SOY BEAN SILAGE.

The soy bean plants dried do not make desirable forage as the cured stalks are rather coarse and hard, and are therefore best fed green or made into silage. Like most leguminous plants, soy beans do not keep as well in the silo alone as when mixed with corn. Consequently, in the trials made at the Maine Station, the beans were cut and put into the silo with corn. The proportion in this case, for convenience, was about fourteen of corn to nine of beans. The silage kept perfectly and when fed out was nearly as green as when it went into the silo. The

animals ate it with great relish and the sheep preferred it to clear corn silage. The composition of the fresh beans and the silage are given in the table on the opposite page.

Two experiments were made at this Station, one with sheep and one with steers, to ascertain the digestibility of the silage described in the preceding paragraph. The detailed results will be given in a later bulletin, but the coefficients obtained are given in the table below. It will be noted that the coefficients obtained for protein and fat are a little below those found by the Massachusetts Station, but are above those of soy bean silage.

DIGESTIBILITY OF SOY BEAN AND CORN FORAGE AND SILAGE.

Kind of Forage.	Kind of animal.	Number of trials.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
Soy bean fodder[1]	Sheep..	8	64.5	18.9	75.1	47.0	73.2	54.0
Corn fodder[5]	Sheep..	12	72.8	44.5	66.4	75.4	72.9	69.5
Soy bean meal and timothy hay[1]	Sheep..	8	69.1	47.1	77.7	61.3	66.2	73.6
Soy bean meal alone[1]	Sheep..	8	78.0	21.3	85.8	......	73.4	84.9
Soy bean (seed)[2]	Sheep..	2	85.0	......	87.0	......	62.0	94.0
Soy bean pods[2]	Sheep..	2	63.0	......	44.0	51.0	73.0	57.0
Soy bean straw[2]	Sheep..	4	55.0	......	50.0	38.0	66.0	60.0
Soy bean hay[2]	Sheep..	6	......	......	70.0	56.0	67.0	30.0
Soy bean silage[3]	Goats...	2	......	......	76.0	55.0	52.0	72.0
Soy bean silage[3]	Steers[4].	2	......	......	55.0	43.0	61.0	49.0
Corn and soy bean silage	Sheep..	3	......	......	65.0	65.0	75.0	82.0
Corn and soy bean silage	Sheep..	2	73.2	42.7	62.6	65.1	79.1	67.7
Corn and soy bean silage	Steers..	2	72.2	31.3	56.4	61.7	80.5	66.7
Corn silage[7]	Sheep..	7	77.0	32.5	65.4	77.4	78.5	82.9
Corn silage[8]	Sheep..	10	73.6	30.3	56.0	70.0	76.1	82.4
Barn yard millet and soy bean silage	Sheep..	4	......	......	57.0	69.0	59.0	72.0

[1] Ninth An. Rep. Storrs Exp. Sta., pp. 248, 250 (1896).

[2] Sixth An. Rep. Storrs Exp. Sta., pp. 160, 161 (1893), taken from European tables by Drs. Dietrich and König.

[3] Ninth An. Rep. Mass. Hatch Exp. Sta., p. 165 (1897).

[4] Very low; probably quite mature when harvested.

[5] Maine flint corn, ears glazed.

[6] Maine station unpublished results.

[7] Maine flint corn, ears glazed.

[8] Immature corn.

YIELD OF DRY MATTER AND PROTEIN.

SOY BEAN VS. CORN FODDER.

The average yield for 7 seasons at the Maine Station of fodder from corn of Sanford or similar variety that will not mature in this climate was a little over 17 tons per acre. For the same period the average yield of green fodder from matured corn was a little over 11 tons per acre. The same season that the Massachusetts Station obtained a yield of 16 tons of Longfellow corn they harvested 10 tons of soy bean fodder from one acre. If we assume an average yield of soy bean fodder at 8 tons and corn fodder at 12 tons per acre, and use in calculation the average of the 13 analyses of each material given in the table, the soy bean would yield 3,560 pounds of dry matter and the corn 5,064 pounds. The soy bean would contain 576 pounds of protein and the corn 552 pounds.

It would therefore appear that a crop of corn will give practically as many pounds of protein as a crop of soy bean, and over 40 per cent more dry matter. Furthermore, the nutrients of the corn are more digestible than those of soy beans. The corn is probably a surer crop, but on the other hand it requires a fertilizer carrying more nitrogen (costing from $10 to $15 per acre) to grow the corn and it is necessary to handle 50 per cent more material to obtain the same weight of protein.

SUMMARY.

Soy beans can be grown in parts of Maine where corn thrives.

Where early corn matures, the early white soy bean will usually mature.

Where Sanford corn ears, the early medium soy bean will form pods.

Soy bean can be grown with less nitrogen than corn.

In order to grow the soy bean most economically, the soil should be inoculated with the organism that forms root tubercles.

The soil should be prepared as for corn or beans and should be free from lumps and clods.

Fertilizers carrying phosphoric acid and potash are essential and on good land no nitrogen is needed if the soil is inoculated for root tubercles.

Sown in drills 16 inches apart, about 3 pecks of seed is needed per acre. If drilled with a grain drill or sown broadcast more seed, perhaps a bushel per acre, will be needed.

Soy beans can be grown with corn, mixing the seed at the rate of 10 quarts of corn and 7 of soy beans. Thus seeded the drills should be about 3 feet apart.

When sown in drills they should be cultivated the same as common beans. In case of narrow spaces between drills, a hand wheel hoe does the work rapidly and well.

The crop is best adapted for feeding green or for silage.

The crop can be harvested by hand or machine. For silage a grain reaper and binder leaves it convenient for handling and for the silage cutter.

A yield of 8 tons of green crop is an average in average seasons on average soil.

Eight tons of soy bean fodder carries about the same amount of protein as 12 tons corn in milk ready for the silo, but it carries only a little more dry matter than 8 tons of corn.

If grown with corn, it can be cut with the corn, by hand or a corn harvester.

When grown by itself for silage, it is best mixed with corn at time of cutting into the silo. About 3 parts corn to 2 parts beans is a very good proportion.

Less protein (the most expensive part of commercial feeding stuffs) need be fed with soy bean and corn silage than with corn silage alone.

According to Farmers' Bulletin 58, "the soy bean is excellent for green manuring and for short rotations with cereal crops. It should be well limed when plowed under as green manure."

FEEDING EXPERIMENTS WITH COWS.

CHAS. D. WOODS.

SOY BEAN SILAGE AND CORN SILAGE COMPARED.

A rough feeding experiment was made by the Station in the winter of 1903-4 in which the feeding value of the soy bean and corn silage was compared with clear corn silage. Six cows were employed and the rations fed and milk produced during each period of the experiment are given in the table below.

It will be noticed that the grain ration during the second period when the soy bean silage was fed, was reduced one pound per day for each animal. The grain mixture was very rich in protein and as the soy bean silage was richer than the corn silage, it was thought this reduction could safely be made without affecting the milk flow. The experiment was not so satisfactory as it would have been had not an epidemic of winter scours attacked the herd when the experiment was in progress. This attack was most severe during the period when the soy bean silage was being fed, consequently the yield of milk from some of the cows was much reduced. From this cause the milk flow of Gertrude was greatly reduced during the second period and her records are not included in the totals in the table.

The details of the experiment follow:

NAME OF COWS AND RATIONS FED FOR THREE PERIODS OF THREE WEEKS EACH.

First period when corn silage was fed.

Name of cows.	Rations.
Ruthele	Corn silage 30 lbs. per day per cow.
Addie 4th	Hay 15 lbs. per day per cow.
Addie 3d	Grain mixture 8 lbs. per day per cow.
Cummings	Corn silage 30 lbs. per day per cow.
Ruth	Hay 15 lbs. per day per cow.
Gertrude	Grain mixture 10 lbs. per day per cow.

Second period when soy-bean silage was fed.

Ruthele	Soy bean and corn silage 30 lbs. per day per cow.
Addie 4th	Hay 15 lbs. per day per cow.
Addie 3d	Grain mixture 7 lbs. per day per cow.
Cummings	Soy bean silage 30 lbs. per day per cow.
Ruth	Hay 15 lbs. per day per cow.
Gertrude	Grain mixture 9 lbs. per day per cow.

Third period same as first.

YIELD OF MILK PER WEEK FOR EACH COW FOR EACH PERIOD.

Feeding Periods.	Week.	Ruth —pounds.	Gertrude* —pounds.	Ruthele —pounds.	Addie 4th —pounds.	Addie 3d —pounds.	Cummings —pounds.	Total* —pounds.
First period of three weeks with corn silage.	First....	212.2	148.9	158.9	116.8	171.2	140.5	
	Second .	198.9	140.5	155.6	121.2	170.1	129.0	
	Third ...	192.6	126.5	154.2	116.6	162.0	133.6	
		603.7	415.9	468.7	358.6	503.3	413.1	2347.4
Second period of three weeks with soy bean and corn silage.	First....	174.4	115.6	147.5	113.7	155.5	133.8	
	Second .	173.3	113.1	150.8	120.5	150.5	131.8	
	Third ...	169.2	113.3	146.0	101.1	146.9	132.6	
		516.9	342.0	444.3	335.3	452.9	398.2	2147.6
Third period of three weeks with corn silage.	First....	174.4	129.2	148.7	110.7	156.6	133.9	
	Second .	169.2	147.6	146.5	104.8	156.8	135.4	
	Third ...	159.9	158.8	110.1	88.2	143.3	119.2	
		503.5	435.6	405.3	303.7	456.7	388.5	2057.7
Average of periods when corn silage was fed, milk	....	553.6	425.6	437.0	331.2	480.0	400.8	2202.6
Soy bean and corn silage period, milk	....	516.9	342.0	444.3	335.3	452.9	398.2	2147.6
Milk solids...............	....	68.7	46.9	60.6	45.8	61.8	50.7	287.6
Butter fat................	....	23.8	16.6	20.4	16.3	22.4	18.3	101.2
Third period when corn silage was fed, milk................	....	503.5	435.6	405.3	303.7	456.7	388.5	2057.7
Solids	....	70.2	56.5	59.2	38.9	63.9	53.6	285.8
Butter fat	....	25.2	22.5	20.7	12.7	22.4	19.4	100.4

* Gertrude omitted from totals.

SUMMARY OF RESULTS IN THE FEEDING EXPERIMENT WHERE MIXED SOY BEAN AND CORN SILAGE WAS COMPARED WITH CORN SILAGE.

Yields per period of 3 weeks.	Average of corn silage periods.	Third period corn silage.	Soy bean period.
	Pounds.	Pounds.	Pounds.
Milk	2203	2058	2148
Milk solids	....	286	288
Butter fat	....	100	101

While the results are not as satisfactory as could be wished, they seem to indicate that on the whole the cows did practically as well on the mixed corn and soy bean silage with one pound less grain as on corn silage with the larger weight of grain.

UNION GRAINS AND OIL MEAL AND BRAN COMPARED.

Union Grains,—Biles Ready Ration, were introduced into the Maine market the past winter by the state agents, Norton-Chapman Company of Portland. Five samples were examined by the Experiment Station in the winter of 1904. The results were given in Bulletin 102* as follows:

"Union grains are a ready made mixture carrying protein and fat according to the guarantee. They are based upon a feeding experiment with Holstein cattle in which Biles Fourex was fed in combination with wheat bran, gluten feed, ground corn, ground oats, and oil meal. For the farmer who must buy all his feed, Union grains at a fair price would probably prove profitable. As a rule, oats and corn are profitable for cows when the feeds are home grown and are expensive feeds to purchase."

RESULTS OF ANALYSES OF UNION GRAINS.*

Name of Feed and Manufacturer or Shipper.	Protein.		Fat.		Station number.
	Found—per cent.	Guaranteed—per cent.	Found—per cent.	Guaranteed—per cent.	
Union Grains—Biles Ready Ration .... J. W. Biles Co., Cincinnati..................	24.19	24.00	7.13	7.00	10058
	23.63	24.00	–	7.00	10245
	24.38	24.00	–	7.00	10346
	25.14	24.00	–	7.00	10561
	24.50	24.00	–	7.00	10574

* Bulletin 102, Maine Agr. Expt. Sta. on Feeding Stuff Inspection.

THE FEEDING TEST.

From a car shipped to Old Town one ton was sent to the Station, and was used in a feeding trial with milch cows. This lot carried 24.19 per cent protein and 7.13 per cent fat. When the Union Grains were received the Station herd was being fed corn silage, mixed hay containing considerable clover, and a

grain mixture, composed of 200 pounds wheat bran, 100 pounds cotton seed meal, and 100 pounds linseed meal. This grain mixture carried somewhat more protein and a little less fat than the Union Grains in comparison with which it was fed. During all the periods the weights of silage hay and grain fed each animal remained constant. The cows doing the maximum work received 8 pounds per day of grain; the others were fed less.

From the herd there were selected 18 animals, 5 Holsteins, 6 Jerseys, 2 Guernseys, 1 Ayrshire and 4 grades. They were from 3 to 6 months in milk and were all, according to their records, doing a moderate amount of work and were fairly uniform in their milk flow from day to day.

These 18 animals were gradually changed from the oil meal mixture to the Union Grains and after 2 weeks were gradually changed back to the oil meal ration. The average yields of milk on the oil meal ration for 7 days prior to the change to Union Grains and 7 days yields after the return to the oil meal rations are compared in the table with 7 days in which the Union Grains were fed.

The table on page 126 shows the milk yield of 18 cows for 2 periods of 7 days on oil meal ration, and one period of 7 days on Union Grains. The hay and silage fed was the same in all periods. The same weight of grain mixture was fed in all the periods.

The individual cows were not tested for butter fat, but the herd milk was tested in each period and ran from 4.1 to 4.3 per cent of butter fat during the test, showing that it was uniform in quality. With the exception of the cow Fan all of the cows gave more milk in the second period on Union Grain than in the average of the first and third periods on oil meal.

The test was not as satisfactory as desirable because of disturbing factors in change of milkers. But these changes did not work in favor of the Union Grains, so that there is no reason to doubt the tendency of the results and so far as this one experiment goes the Union Grains showed themselves a better food for milk production than the oil meal ration. The Union Grains cost somewhat more, however, than the mixture of oil meal and bran.

YIELD OF MILK PER WEEK FOR EACH COW FOR EACH PERIOD.

	KIND OF GRAIN MIXTURE AND YIELD OF MILK.			
	Oil Meal and Bran.			Union Grains.
	First period—seven days.	Third period—seven days.	Average first and third—seven days.	Second period—seven days.
	Pounds.	Pounds.	Pounds.	Pounds.
Guernsey	141.4	106.6	124.0	117.2
Dorothy, Ayrshire	156.5	150.5	153.0	161.5
Hunton 2d, Holstein	90.3	70.5	80.4	92.6
Hunton, Holstein	134.5	122.3	128.4	142.0
Abbie B., Holstein	120.6	109.9	115.3	119.7
Roxy, Holstein	180.5	174.5	177.5	189.5
Fan, Holstein	143.1	141.7	142.4	129.3
Bessie, Grade	115.8	98.0	106.9	119.1
Ethel, Jersey	118.6	114.1	116.3	119.2
Shaw, Grade	113.7	102.4	108.1	112.5
Celia, Grade	150.1	107.8	128.9	148.3
Judy, Jersey	97.8	84.9	91.4	106.4
Posey, Grade	140.3	112.8	126.5	120.6
Adle S., Jersey	97.0	86.3	91.7	97.0
Pansy, Jersey	83.7	59.8	71.7	81.0
Lily, Guernsey	69.5	55.0	62.8	65.4
Tulip, Jersey	72.9	55.2	64.0	74.0
Maud, Jersey	91.4	68.2	79.8	85.5
Total milk	2,117.7	1,820.5	1,969.1	2,080.9

ALFALFA.

CHAS. D. WOODS.

During the past 25 years many attempts have been made to grow alfalfa in New England. These attempts have, however, met with only partial success, and there is probably, in all New England, not a square rod of alfalfa with a good stand that has been established 5 years. Indeed, it is doubtful if, unless in the most sheltered situation, a single plant could be found that is five years old. The nearest approach to success that has come to the writer's knowledge was that of a farmer at Amesbury, Mass., and it is a significant fact that he has no alfalfa growing at the present time.

While the writer was connected with the Storrs (Conn.) Station a number of attempts to grow alfalfa were made, both on the station land and in co-operation with farmers in different parts of the state. While a few isolated plants near the shore of Long Island Sound persisted for several years, practically all died the first, or, at the latest, the second winter.

Alfalfa has been tried many times in this State, but without much promise of success. Several farmers sowed alfalfa in the spring of 1903, and in a few instances a fair percentage of the stand survived the winter of 1903-4. A small patch in a garden at Houlton, sown in the spring of 1902, probably contains as old plants as any in the State. Two cuttings were made from this in 1902, four in 1903, and three the present season. It grew luxuriantly, and most of the plants survived the first winter, but nearly two-thirds died in the winter of 1903-4. There are also in Fort Fairfield a few plants still standing on the edge of a driveway, where they were sown in 1902.

Because alfalfa has been successfully grown where formerly it was thought impracticable and because of a large number of inquiries, it was deemed best for the Station to give it another trial under the most favorable conditions of soil and treatment possible. About 4 acres are now being grown in co-operation with farmers in Orono, Penobscot county; in Princeton, Washington county; and in Houlton, Maple Grove and Fort Fairfield

in Aroostook county. The seed used was specially procured by the United States Department of Agriculture from the cold mountainous regions of Turkestan and had been inoculated with alfalfa bacteria. Root tubercles have developed abundantly on all the plots. Care was taken to select land that seemed to be naturally well adapted to alfalfa as to soil, subsoil and drainage. It was thoroughly prepared and a good stand and growth was for the most part obtained. The sowing was light (15 pounds of seed to the acre) so as to grow seed for further work if the plants should survive the first winter. All the land was well fertilized, part of it was limed and part treated with ashes. Part of the seed was broadcasted and part sown in drills. That in drills was kept free from weeds by hand wheel hoe and hand work. The broadcast portions were cut whenever the weeds seemed to endanger the alfalfa. The drilled has grown much better than the broadcast and at the cutting in August, the drilled gave on all the plots nearly a ton of rather undercured alfalfa hay.

In order to be of much value to Maine agriculture, alfalfa must be able to stand not one, but several winters. The Station does not advise anyone to grow alfalfa at present in Maine, unless in a small experimental way. Next spring the Station hopes to have a limited amount of Montana grown seed, from the United States Department of Agriculture at Washington. This will probably prove as hardy as the Turkestan seed. So far as the amount received will allow, the Station will supply enough seed for an eighth of an acre on condition that the cultural instructions will be followed and the results reported to the Station.

HOME MIXED FERTILIZERS.

CHAS. D. WOODS.

Commercial fertilizers have been commonly employed for more than a generation and in that time there has been comparatively little advance made by the farmer in their use. Where money crops are grown it has become the custom of many successful growers to fertilize liberally, with only slight regard to the needs of the crop and the fertility of the land. For instance, in Aroostook County the growers of potatoes have found that it pays to use large amounts of commercial fertilizers upon this crop, and one finds farmers applying 1000 to 1800 pounds of a high grade fertilizer to the acre without reference to the preceding crop, either in the choice of the kind of fertilizer or the amount to be used.

When commercial fertilizers were first placed upon the market, there was a good deal of excuse for its unwise and wasteful use. While it is not a simple matter, for even the most expert, to always correctly apply the principles of feeding plants to field practice, and while many conditions such as season, tilth, and other circumstances arise both within and beyond the control of the grower, the principles underlying the production and maintenance of soil fertility have been so clearly and frequently stated, that there is comparatively little excuse for slipshod practice in the purchase and use of commercial plant food. The subject of the intelligent use of farm manures and commercial fertilizers is too large to be entered upon at this time and place. Many valuable, readable and readily understood books have been written upon this subject and can be had from any book dealer at prices within the reach of all. Farmers' Bulletin 44, of the United States Department of Agriculture, takes up in a concise manner the composition and use of commercial fertilizers. By applying to your Congressman or to the Secretray of Agriculture, Washington, D. C., a copy may be had free. A little book on "Manures: How to Make and How to Use Them," pub-

lished by the seedsmen, W. Atlee Burpee and Company, Philadelphia, is a comprehensive book that costs 50 cents; and Professor Voorhees' treatise on Commercial Fertilizers, published by Macmillan and Company, New York, for $1.00, gives a clear and not very technical presentation of the principles underlying the use of the different kinds of plant food for different crops and soils. If one feels that because of ignorance it would be better to buy ready mixed goods than to attempt home mixing, it must be remembered that there is little if any more likelihood of making mistakes in the proportions when mixing than there is of buying ready mixed goods unsuited to the purpose. A farmer complained this year about a fertilizer that he used for potatoes and inquiry revealed the fact that he had used on land in poor condition a fertilizer intended for seeding down, which carried very little nitrogen and with almost none of its constituents in a readily available form. It is difficult to believe that one purchasing and mixing chemicals for the first time would have made such a serious mistake, in the forms and proportions of plant food.

WHY USE HOME MIXED GOODS.

The reasons for and against home mixing are few and easily stated.

In general, if considerable quantities of fertilizers are used, there can be a considerable saving in the purchase.

When separate materials are purchased there is less likelihood of being deceived. This does not apply, however, with very great force when the goods are purchased from the well known and reliable manufacturers.

In home mixing the farmer can readily change the mixture so as to more nearly adapt it to the requirements of different crops. While the manufacturers do this to a considerable extent, it rarely happens that a farmer growing several kinds of crops takes advantage of this fact. He usually employs the same brand regardless of the crop, whether grown on a clover turf or with or without farm manure. This leads to the most important reason of all for home mixing, stated in the next paragraph.

There is a great educational value in home mixing. The use of an unknown mixture gives little information, and the farmer that has for years used ready mixed goods knows but little more as to the needs of his land and crops than when he began. The

purchase of unmixed goods will lead to an intelligent use. It is impossible to imagine an intelligent man using unmixed goods on different crops and soils through a series of years without coming to a fairly clear understanding of the chemical needs of the soil and crops, even though he may know nothing of the principles of chemistry. It is furthermore equally difficult to conceive of such a man using unmixed goods year after year without being impelled to study and to read. Just as hundreds of skilled, intelligent feeders have been developed by reading, study, experiment and observation, so equally scientific users and conservers of plant food would be the result of intelligent home mixing.

Two reasons are commonly advanced against home mixing:—

On small purchases there is little or no saving. This is a matter of dollars and cents, and inquiry as to cost of materials, and the same *weights of plant food* ready mixed, will enable any one to answer the question of economy for himself.

It is also claimed that owing to the lack of proper facilities the farmer can not mix as well as the manufacturers. That he can do so with a tight barn floor, and no other implements than a shovel, a screen and a rake has been shown over and over again in every state in the East and South.

A MANUFACTURER'S VIEW OF HOME MIXING.*

"As to mixing at home, they who do it cannot readily obtain their materials at first hand or in an absolutely raw condition. In the first place, the phosphate or bone must be ground and treated with sulphuric acid if available or soluble phosphoric acid is desired. This cannot be done on the farm. The tankages, blood or fish must also be ground for home mixing, also the chemicals, for most of them come in a lumpy condition and need remilling. For this expense of preparation the home mixer must of necessity pay some one, for it is a part of the cost of manufacture. In fact it is the larger part, for when the raw materials are prepared, the phosphates ground and acidulated, and the other materials put into a fine mechanical condition the most important and costly steps in the process of manufacture have been taken. The last step, of putting them together, is the least expensive of them all.

* Extracts from a personal letter.

"There may be a few farmers who can figure out a saving by home mixing, but this is not the case with the great mass of farmers; and even if the home mixers constituted the great mass they would not be able to get their goods direct but would have to take them through distributing agencies in order to secure them in time. In any event, they must pay for the preparation of the materials, freights, bags, and to this cost will also be added a certain percentage for losses and shrinkage, whether they buy the mixed or the unmixed goods; and finally they must pay a profit, for all business is based on a fair return.

"I have never objected to home mixing and to the Experiment Stations urging it for I know that through it many farmers who have not used chemicals will be led to use them and will eventually become large users of mixed fertilizers. I consider it an excellent educational process and a good introduction to the use of mixed manures. Some of our best customers for complete fertilizers, I may say *the* best customers that we have ever had began as home mixers."

IS HOME MIXING PRACTICABLE?

To make it evident that Maine farmers do and can mix goods that are in all particulars equal to the best factory mixed, the Station made in 1904 cooperative experiments upon home mixing with farmers in Brunswick, Houlton and Fort Fairfield (Maple Grove).

The completeness of the mixing is illustrated by the following: A number of farmers at Brunswick clubbed together and purchased bone tankage, cottonseed meal, nitrate of soda, acid phosphate and sulphate of potash. The tankage was not in as good mechanical condition as was desirable but this was remedied by passing it over a screen with 3 meshes to the inch, and rejecting all that did not go through. The coarser particles were not wasted but were used around fruit trees, etc., where the nitrogen and phosphoric acid would slowly become available and utilized.

After all of the goods had been screened, samples for analysis were taken by the writer. The materials were then weighed out, and spread out in layers, one above the other, on the barn floor, care being taken to put the bulkiest materials at the bottom. They were then mixed by shoveling together four times and bagged. The writer took a sample of the mixed goods, and the

calculated composition and that found is given in the following table:

COMPOSITION OF A HOME MIXED "POTATO FERTILIZER," CALCULATED FROM THE MATERIALS USED, COMPARED WITH THE COMPOSITION OF THE MIXED GOODS AS FOUND BY CHEMICAL ANALYSIS.

	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Calculated	4.00	11.30	7.33
Found	3.91	11.02	7.38

This agreement between "calculated" and found" is closer than could always be expected, for it is indeed inside of the limits of errors in chemical analysis.

To see what would be the result if the sample of the ingredients were taken from unscreeneed goods in large lots, and shippers' weights assumed as correct, the following results were obtained in mixing by men without previous experience.

COMPOSITION OF A HOME MIXED "POTATO FERTILIZER" MADE FROM MANUFACTURERS' WEIGHTS OF GOODS, CALCULATED FROM THE ANALYSIS OF SAMPLES TAKEN AT RANDOM FROM THE STOCK OF CHEMICALS, COMPARED WITH THE COMPOSITION OF THE MIXED GOODS AS FOUND BY CHEMICAL ANALYSIS.

	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Calculated	4.3	10.2	7.3
Found	4.1	9.9	7.6

While these results do not agree nearly as well as in the case of the more carefully weighed and sampled goods, they run as close as many of the ready mixed goods sold in the State do to their guarantees.

The mechanical condition of these goods was excellent. They were used in the potato planter, and even in the old type Robbin's planter the fertilizer was distributed as freely and evenly as could be asked. The cottonseed meal and tankage were so dry that the use of a filler was unnecessary.

About 40 acres of potatoes were grown with the above home mixed goods, the fields being situated in three towns and two counties. The results will be given in detail in a bulletin now in preparation. The more general results are here briefly stated. In general large crops, ranging in Aroostook County from 275 to 380 bushels per acre, were obtained. On early planted potatoes, and where the season was long enough for the crop grown on the home mixture to mature, the yields were as large as where the standard commercial fertilizers were liberally used. The tops kept greener in color during the last half of the growing season with the home mixture. September 1 there was a severe frost all over Northern Maine. The late potatoes grown upon the home mixture had greener and more succulent vines than those upon the standard fertilizers and in consequence were damaged much more by the frost. In fact the vines of the late planted potatoes on the home mixed goods were practically killed at this time, while the same varieties planted at the same time upon the standard potato fertilizer continued to grow after this frost. As a result the potatoes were larger and better ripened with these than upon the home mixed plots. For quick maturing, the home mixed goods apparently carried too much slowly available nitrogen and too little available phosphoric acid—a condition that can be readily remedied in a formula.

KINDS OF INGREDIENTS.

There are various materials that are used in the manufacture of fertilizers, but because of Maine's distance from the commercial centers, it will rarely be profitable to purchase any but materials carrying high percentages of plant food. For instance, the cost of bagging, cartage and freight on a ton of muriate of potash, carrying 1000 pounds of actual potash, would be no greater than the freight on a ton of kainit carrying only 250 pounds of potash, and if the kainit could be bought for one-fourth the price of the muriate it would, because of the freight, still be the more expensive source of potash. Furthermore, in mixing and applying, four times as great weight would have to be handled.

The kinds of fertilizing materials that would usually be most profitable and economical sources of plant food for home mixing in Maine are given in the table which follows. It will be under-

stood that this class of goods is always sold under a guaranteed percentage composition, and the percentages here given are only approximate and for guidance in inquiry.

AVERAGE COMPOSITION OF CHIEF COMMERCIAL FERTILIZER MATERIALS.

	Nitrogen.	Phosphoric Acid.		
	Per cent.	Available—per cent.	Total—per cent.	Potash—per cent.
Nitrate of soda	16	....	....	....
Nitrate of potash	14	....	....	44
Sulphate of ammonia	20	....	....	....
Dried blood, high grade	13	....	....	....
Dried blood, low grade	10	....	4	....
Concentrated tankage	12	....	1	....
Bone tankage	5.5	....	12	....
Portland Rendering Co's tankage in 1904	4.9	4.2	16.3	....
Portland Rendering Co's tankage in 1904, screened	5.5	7.3	16.0	....
Dried fish scrap	8	....	7	....
Cotton-seed meal	7	....	1.5	2
Acid phosphate	....	13	14	....
Raw ground bone (bone meal)	4	8	22	....
Steamed bone	2	9	25	....
Muriate of potash	....	....	....	50
Sulphate of potash (high grade)	....	....	....	50
Kainit	....	....	....	12
Hard wood ashes (unleached)	....	....	1	5
Hard wood ashes (leached)	....	....	1	2

Fertilizing materials should be dry and fine. If moist there is danger of their lumping. Not only the evenness of the mixture, but the availability of forms of plant food is directly dependent upon the fineness of the goods. Ground bone is only very slowly available unless it is finely ground. In ordering chemicals it should always be demanded that they be finely ground and in good mechanical condition, for the mixed goods will not be satisfactory for machine use unless the ingredients are in good shape.

In case no dry and bulky materials, e. g. cottonseed meal, or tankage, are used in the formula, it will be necessary to use some material such as dry loam, or "muck" as an absorbent and filler.

WHERE UNMIXED FERTILIZERS CAN BE PURCHASED.

Unmixed goods can be purchased in Maine from the Sagadahoc Fertilizer Company, Bowdoinham, The John Watson Company, Houlton, and the agents of the American Agricultural Chemical Co. Tankage can be had from the Portland Rendering Co., Portland. Out of the State unmixed goods can be obtained from the fertilizer manufacturers. The following Massachusetts Companies do business in this State: The American Agricultural Chemical Co., 92 State St., Boston, Mass.; The Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.; The New England Fertilizer Co., 44 North Market St., Boston, Mass.; The Parmenter & Polsley Fertilizer Co., Peabody, Mass.; The Russia Cement Co., Gloucester, Mass.; and Swifts Lowell Fertilizer Co., 43 North Market St., Boston, Mass.

Edmund Mortimer & Co., 13 William St., New York, N. Y., make a specialty of selling chemicals for home mixing.

PLANT FOOD REMOVED BY CROPS.

It serves as something of a guide in the application of fertilizers to know the requirements of different crops as measured by the amount of plant food that is removed by a single crop. Of course such figures are only approximate and can not be blindly followed. For instance the legumes, members of the pea and clover family, have the power of acquiring a very considerable part of their nitrogen from the air by the aid of minute organisms which form enlargements known as root tubercles upon the roots of this family of plants.* For this reason this class of plants, although among the richest in nitrogen, and removing large amounts of this fertilizing ingredient, can be grown by the use of mineral fertilizers carrying almost no nitrogen.

The table which follows gives the approximate amounts of nitrogen, phosphoric acid and potash that are removed by quite large yields of the more common farm crops. Not only the

* For a discussion of this see Report of this Station for 1897.

fruit, seeds, tubers, etc., are taken into account in the figures in the table, but the plant food removed in the tops, straw, etc., is considered as well.

THE APPROXIMATE AMOUNT OF NITROGEN, PHOSPHORIC ACID AND POTASH CONTAINED IN THE TOTAL YIELD OF DIFFERENT CROPS, INCLUDING STRAW, VINES, ETC., FROM ONE ACRE IN ONE YEAR.

Kind of Crop.	Yield per Acre.†	Nitrogen —pounds.	Phosphoric acid —pounds.	Potash —pounds.
Barley	40 bush.	74	23	68
Buckwheat	30 bush.	53	21	60
Oats	60 bush.	60	22	50
Wheat	30 bush.	62	20	26
Corn, ripened	60 bush.	84	32	34
Corn fodder, green	12 tons.			
Potatoes	300 bush.	55	25	85
Turnips	700 bush.	80	52	180
Beets	600 bush.	110	40	190
Clover hay*	3 tons.	123	27	132
Timothy and red top	3 tons.	69	27	58
Mixed hay (some clover)	3 tons.	84	21	93
Beans*	40 bush.	100	40	70

* Legumes that under favorable conditions derive a large part of their nitrogen from the air.

† Larger yields than the average are purposely given, but no larger than should be striven for as an average.

PLANT FOOD IN THE SOIL AND SOD.

The amount of available plant food in the soil has a very important bearing upon what should be applied. There is a wide spread belief that a chemical analysis of a soil will serve as a guide to the selection and use of fertilizers. While in a rare and occasional instance a chemical analysis will throw light upon the question of soil fertility, such an analysis is, unfortunately, of very little help in determining the needs of the soil for crop growing. The chemist can tell how much of each ingredient the soil contains, but cannot tell whether it is in avail-

able form. Moreover different plants have different feeding capacities, so that the plant food which would be available to one class of plants might not to another. This question can be best answered by putting it directly to the soil in a so-called soil test experiment.†

If a farmer has not experimented with his soil so that he knows to what fertilizing elements it most readily and profitably responds, he must be guided in the purchase of plant food by general principles. And this is as true in the purchase of mixed as unmixed goods. In either case there is considerable uncertainty. The purchase of unmixed goods, however, has the advantage that the farmer knows what he has used, and if he is observant and keeps record of his management, he will know where he made the mistake and how to avoid it the next season.

In addition to the plant food in the soil, the farmer has at his disposal the manure from the farm animals and a very considerable amount in that left in roots and stubble from the preceding crop. A few figures illustrative of this are given in the table which follows.

AMOUNT OF NITROGEN, PHOSPHORIC ACID AND POTASH LEFT IN THE ROOTS (TO THE DEPTH OF 6 INCHES) AND STUBBLE IN ONE ACRE AFTER THE CROP HAS BEEN REMOVED AND A NEW GROWTH HAS STARTED, AND IN FARM MANURE.

Kind of Plants.	Nitrogen, pounds.	Phosphoric acid, pounds.	Potash, pounds.
Timothy and red top, average of 2 experiments	62	15	31
Clover, average of 3 experiments	36	10	22
One ton, rich stable manure*	10	10	8

*Manure is extremely variable in composition and weight. A cord of manure will weigh from 3 to 4 tons. Farmers' Bulletin 192, of the U. S. Department of Agriculture, on farm manures, can be had free from your Congressman, or the Secretary of Agriculture, Washington, D. C.

† Circular No. 8 of the Office of Experiment Stations of the United States Department of Agriculture explains how such a test can be made. A postal card sent to the Secretary of Agriculture, Washington or to your Congressman will bring this circular free.

HOW TO MIX CHEMICALS FOR USE.

After the formula has been decided upon, and the chemicals purchased, the mixing is readily attended to in accordance with the following or some similar way.

The apparatus needed consists of: Tight floor; platform scales; shovel with square point; an iron hand rake, and a sand screen with 3 meshes to the inch (frame about 4½ ft. by 1½).

Screen all the materials. Pulverize all lumps and pass through the screen before adding to the pile. Nitrate of soda is apt to be lumpy. If emptied out, slightly moistened and allowed to stand over night, the lumps will fall apart on raking. When practicable the nitrate should be reground at time of purchase.

Spread the proper weight of the most bulky material on the floor to a depth of six inches. Make the top level and spread the proper weight of the next most bulky material on top of the first. Proceed in like manner until all the different constituents have been added to the pile. Shovel over the whole three or four times, taking care to carry the shovel to the bottom of the pile and to mix as thoroughly as possible. After the goods are mixed, they can be stored in bulk or put into bags or barrels until they are needed. It is usually much more economical of time for the farmer to mix the chemicals he may need before the rush of spring work. With well dried materials in good mechanical condition, the mixed goods will keep for months if stored in a dry place. It is better, however, to mix the goods as late as practicable without interfering with other work.

DEVISING FORMULAS.

Although the selection of a formula for home mixing fertilizers, like compounding rations for stock, is a good deal more than mere arithmetic, the data given in the tables on pages 135 and 137 are suggestive and will prove helpful. The correct use of commercial fertilizers involves the supply of plant food that a given soil lacks to produce a good yield of a given crop. Hence to fertilize to the best advantage, the soil to be used must be known.

All soils contain much more plant food than is needed to grow many crops. The larger part of this is not immediately avail-

able. It is a part of good farming to make this plant food available and in no way can this be as effectively brought about as by thorough preparation of the soil before planting and, in the case of hoed crops, by thorough cultivation during the growing season. The plant food in soil is, in general, available to growing plants in proportion to the smallness of the particles of soil. Too strong emphasis cannot be put upon the proper plowing, harrowing and other mechanical preparations of the soil and in the case of hoed crops, constant thorough cultivation during the growing season.

While recognizing the danger that may come from a blind following of definite directions for general practice, the following quite specific suggestions are made for a few general crops. *It is to be borne in mind in using these formulas that they are only suggestive and that different conditions of soil make such different treatment essential that a formula which may prove successful on one farm may not be equally so on another.*

In the suggested formulas the composition as given in the table on page 135 is assumed for the chemicals. The analysis of the Portland Rendering Companies screened tankage as found in 1904 and given in the table is used for the composition of tankage.

FORMULAS FOR POTATOES.

In 1904 there were licensed in Maine rather more than 40 brands of fertilizers in which the word potato entered into the name. It is very doubtful if in more than one-third of these brands there was any reason, other than the attraction of the name, to call them potato fertilizers. More than half of them have the composition of general purpose goods with about 3 per cent nitrogen, 8 per cent available phosphoric acid, and 3 per cent potash. Those that would be taken seriously as intended for potatoes carry less phosphoric acid and relatively more nitrogen and considerably more potash. Nearly all of the companies put out a brand with the word potato in its name that carries about 3.5 per cent nitrogen, 6 per cent available phosphoric acid and 8 or 10 per cent potash.

A crop of 300 bushels of potatoes will remove from the soil about 55 pounds of nitrogen, 25 pounds phosphoric acid and 85 pounds of potash. It is quite a common practice in Aroostook

County to use 1000 to 1200 pounds per acre of such a fertilizer as last named, which would furnish about two-thirds the required nitrogen for a 300 bushel crop, three times as much phosphoric acid and rather more than enough potash.

In general the potato plant thrives best in a soil abundantly supplied with all fertilizing elements. In the early stages of growth nitrogen is particularly demanded, and hence a considerable part of the nitrogen should be in water soluble form, so that it may be readily available early in the season. Later, when the tubers are forming, there is special demand for phosphoric acid and potash.

The formula used by a number of farmers in Cumberland and Aroostook Counties in 1904 at the rate of 900 to 1300 pounds per acre, and giving a yield from 100 to 140 barrels (275 to 380 bushels) per acre was as follows:

FORMULA (NO. 1) FOR 300 BUSHELS POTATOES, USED IN 1904. SATISFACTORY WHERE THE SEASON WAS LONG ENOUGH TO MATURE THE CROP. FOR ONE ACRE.

	Weight used —pounds.	Nitrogen —pounds.	Phosphoric Acid. Available —pounds.	Phosphoric Acid. Total —pounds.	Potash —pounds.
Tankage*	500	27.7	36.5†	80.2	....
Cotton seed meal	200	13.7	....	7.2	5.8
Nitrate of soda	100	14.7	....	....	....
Acid phosphate	400	....	68.2	71.0	....
Sulphate of potash	200	....	....	....	96.8
	1,400	56.1	104.7	158.4	102.6
Percentage composition		4.0	7.5	11.3	7.3
Percentage composition as used in Aroostook county*		4.3	7.4	10.2	7.3

*In the Aroostook county lots 420 pounds of a tankage with less phosphoric acid and more potash was used, with a resulting higher percentage of nitrogen and lower percentage of potash.

†This represents the amount of phosphoric acid that is "citrate soluble" as found by chemical analysis, but it is not as speedily available to the growing crop as that of acid phosphate.

The potash was applied in the form of sulphate instead of muriate because it is commonly held that the sulphate produces a better quality of potatoes. Unpublished results of experiments by this Station do not confirm this opinion. Although this formula did as well with early planted potatoes as the commercial fertilizers with which it was compared, it had a tendency to prolong the period of growth, with the result that on late potatoes, particularly in the northern part of Aroostook County, the vines were green and vigorous at the time of the first severe frost, which this year was early, September 1. The other parts of the fields, planted with the standard commercial fertilizers, stood the frost much better than these tenderer vines grown on the above formula. At digging, the yield with late planted potatoes was larger and the individual potatoes were larger and better matured on the standard brand of mixed goods than on the above formula. For late planting with a short season it would probably be advantageous to use a formula with more water soluble nitrogen and more available phosphoric acid, as an excess of this latter seems to hasten the ripening of the crop. Some such a formula as the following might be used:

A COMPLETE FORMULA (NO. 2) FOR 300 BUSHELS POTATOES. THE LARGE EXCESS OF PHOSPHORIC ACID WILL TEND TO EARLY MATURITY. FOR ONE ACRE.

	Weight used—pounds.	Nitrogen—pounds.	Phosphoric Acid.		Potash—pounds.
			Available—pounds.	Total—pounds.	
Nitrate of soda*	200	32	....	....	....
Screened tankage	200	11	15	32	....
High grade dried blood†	100	13	....	....	....
Acid phosphate	500	....	65	70	....
Sulphate of potash	200	....	....	....	100
Total	1,200	56	80	102	100
Percentage composition		4.7	6.7	8.5	8.3

* Seventy-five pounds of sulphate of ammonia could be well used in place of 100 pounds of the nitrate.

† 150 pounds ordinary dried blood or 200 pounds cotton seed meal might be used in place of the high grade dried blood.

If the potatoes are to be grown on sod land and a good stubble of clover or mixed grasses with the aftermath has been plowed under, or if stable manure is used, much of the organic nitrogen needed for the crop will, as shown in the table on page 138 be supplied by either of these materials. Under such conditions a formula containing nitrate and only a small amount of other nitrogen would doubtless give good results. Some such a formula as the following could be used:

FORMULA (NO. 3) FOR 300 BUSHELS POTATOES, TO BE USED ON SOD LAND WHERE A GOOD STUBBLE AND AFTERMATH HAS BEEN PLOWED UNDER, OR IN CONNECTION WITH FARM MANURES. FOR ONE ACRE.

	Weight used—pounds.	Nitrogen—pounds.	Phosphoric Acid. Available—pounds.	Phosphoric Acid. Total—pounds.	Potash—pounds.
Nitrate of soda	100	16	....	....	....
Screened tankage	200	11	15	32	....
Acid phosphate	300	....	39	42	....
Sulphate of potash	200	....	....	....	100
Total	800	27	54	74	100
Percentage composition		3.4	6.8	9.2	12.5

The tankage in the above will be sufficient to keep the fertilizer in good mechanical condition without the use of a filler.

CORN.

Corn is a crop that uses a large amount of nitrogen. It is usually grown upon sod land, or with farm manure, or both. Indeed, it is doubtful if under ordinary conditions it would prove a profitable crop to be grown on somewhat exhausted soil with commercial fertilizers alone. Experiments at the Massachusetts Station indicate that it does best with an excess of potash. Three formulas are suggested for use on sod land and in conjunction with farm manure. In the first of the following formulas the materials will not of themselves make a good dry

mixture for machine planting. Two or three hundred pounds of dry loam, muck, or other suitable material will be needed to mix with the chemicals to make a mixture in good mechanical condition. The first formula contains only about one-sixth of the nitrogen needed to grow the crop. With a good sod and especially with a liberal dressing of farm manure, that will be all that is needed. The second and third formulas carry more nitrogen and the dry bulky tankage or cottonseed meal do away with the necessity of a filler.

FORMULAS FOR CORN ON SOD LAND OR IN CONJUNCTION WITH FARM MANURE. FOR ONE ACRE.

	Weight used —pounds.	Nitrogen —pounds.	Phosphoric Acid. Available —pounds.	Phosphoric Acid. Total —pounds.	Potash —pounds.
(No. 4.)					
Nitrate of soda	100	16	....	....	....
Acid phosphate	400	....	52	64	....
Muriate of potash	150	....	....	....	75
Total	650	16	52	64	75
Percentage composition	....	2.5	8.0	9.9	11.5
(No. 5.)					
Nitrate of soda	100	16	....	....	....
Screened tankage	200	11	15	32	....
Acid phosphate	300	....	39	42	....
Muriate of potash	150	....	....	....	75
Total	750	27	64	74	75
Percentage composition	....	3.7	8.5	9.9	10.0
(No. 6.)					
Nitrate of soda	100	16	....	....	....
Cotton seed meal	200	14	....	3	4
Acid phosphate	400	....	52	64	... .
Muriate of potash	150	....	....	....	75
Total	850	30	52	67	104
Percentage composition	....	3.5	6.1	7.9	12.2

SEEDING TO GRASS.

In this State spring seeding, with a shade crop of grain, (usually oats) is the common practice. Summer seeding is practiced to some extent, but does not fit in to the usual rotation as well as spring seeding. It is doubtful if it is profitable to grow oats or wheat in this State except as a nurse crop for grass. They are exhaustive of plant food, particularly nitrogen, and in proportion to the value of the crop are costly to grow. In spring seeding with grain it is, of course, necessary to take the demands of the grain as well as the grasses into account in selecting a fertilizer. Where seeding follows corn in the rotation, it usually happens that all of the farm manure is used on the corn crop, and all the plant food for the grasses must be otherwise provided. Where potatoes precede seeding, however, usually farm manure can be used in seeding down. The old, and still by far more common way, is to seed with rather slowly available fertilizers, and crop the field until the grass yield is too small to be profitable. A better way is to fertilize the land annually and in case it is desired to keep the field in grass more than one or two years to top dress with soluble commercial fertilizers. Based upon these various methods of treatment and taking into account the amounts of fertilizing materials removed by each crop (see page 137), the following formulas are suggested. It should be remembered that thorough preparation of the soil is as essential with grass as any crop.

A FORMULA (NO. 7) FOR SPRING SEEDING WITH OATS AS A NURSE CROP IN CONJUNCTION WITH LIBERAL APPLICATIONS OF FARM MANURE.* FOR ONE ACRE.

	Weights used—pounds.	Nitrogen—pounds.	Phosphoric Acid. Available—pounds.	Phosphoric Acid. Total—pounds.	Potash—pounds.
Nitrate of soda	100	16	....	....	....
Acid phosphate	400	....	52	56	....
Muriate of potash	250	....	....	....	125
Total	750	16	52	56	125
Percentage composition	....	2.1	6.9	7.5	16.5

*If desired to apply by machinery, it would be necessary to mix with about 200 pounds of some fine, dry material, as muck, or loam.

A FORMULA (NO. 8) FOR SPRING SEEDING WITH OATS WITHOUT FARM MANURE. FOR ONE ACRE.

	Weights used —pounds.	Nitrogen —pounds.	Phosphoric Acid. Available —pounds.	Phosphoric Acid. Total —pounds.	Potash —pounds.
Nitrate of soda	100	16	....	....	....
Screened tankage	500	28	36	80	....
Acid phosphate	200	....	26	28	....
Muriate of potash	250	....	....	....	125
Total	1,050	44	62	108	125
Percentage composition	....	4.2	5.9	10.3	11.9

This will make a dry fertilizer that can be applied with machinery.

A FORMULA (NO. 9) FOR SUMMER OR FALL SEEDING WITH FARM MANURE. FOR ONE ACRE. AT SEEDING.

	Weights used —pounds.	Nitrogen —pounds.	Phosphoric Acid. Available —pounds.	Phosphoric Acid. Total —pounds.	Potash —pounds.
Acid phosphate	100	....	13	14	....
Muriate	170	....	....	....	38
Total	270	....	13	14	38
Percentage composition	....	....	6.5	7	19
The following spring apply					
Nitrate of soda	100	16	....	....	....
Acid phosphate	200	....	26	28	....
Muriate	250	....	....	....	100
Total	450	16	26	28	100
Percentage composition	....	3.6	5.8	6.2	22.2

A FORMULA (NO. 10) FOR SUMMER OR FALL SEEDING WITHOUT FARM MANURE. FOR ONE ACRE. AT SEEDING.

	Weights used —pounds.	Nitrogen —pounds.	Phosphoric Acid. Available —pounds.	Phosphoric Acid. Total —pounds.	Potash —pounds.
Nitrate of soda	100	16	....	....	....
Screened tankage	400	22	29	64	....
Muriate of potash	100	....	....	....	50
Total	600	38	29	64	50
Percentage composition	....	6.3	4.8	10.7	8.3

The following spring apply the chemicals suggested for use with formula 9.

The Rhode Island Station has experimented with top dressing for grass for a series of years and has found it profitable. Of course it should not be practiced unless there is a good stand of grass plants. It recommends the following:

FORMULA (NO. 11) FOR SPRING TOP DRESSING GRASS LAND, SUGGESTED BY THE RHODE ISLAND EXPERIMENT STATION.*

	Weights used—pounds.	Nitrogen—pounds.	Phosphoric Acid Available—pounds.	Phosphoric Acid Total—pounds.	Potash—pounds.
Nitrate of soda	350	54	....	....	....
Acid phosphate	400	....	52	56	....
Muriate of potash	250	....	....	....	125
Total	1,000	54	52	56	125
Percentage composition	....	6.8	6.5	7.0	15.6

* Bulletin 90, Rhode Island Experiment Station.

THE LEGUMES.

The family of the legumes, which include such plants as clover, peas, vetches and beans, carry much higher percentages of nitrogen than most other plants and differ, so far as known, from all other plants in that they can obtain all or practically all their nitrogen from the free nitrogen of the air. This they cannot do directly, but by the assistance of minute organisms which grow upon their roots. (See page 136). In order to thus acquire nitrogen it is necessary that the soil contain the proper organism, usually a different kind for each legume. If the soil is not stocked with the proper organism it can be, either by applying soil from a field known to carry them, or by "cultures." The soil almost everywhere in Maine is stocked with the organisms that work upon clover, peas and beans. Because of their power under these conditions to acquire the larger part of their nitrogen from the air, the legumes can be fertilized very differently, and at less cost than other plants. Formulas, carrying a little nitrogen to give the plants a start, and furnishing the needed minerals for the crop, follow. To make these in sufficiently good mechanical condition for use in machinery, they need to be mixed with about 150 pounds fine dry muck, loam or similar materials.

A SUGGESTED FORMULA (NO. 12) FOR THE CLOVERS, OR ALFALFA WITHOUT OTHER MANURE AND ON LAND CARRYING THE PROPER ROOT TUBERCLE ORGANISMS. FOR ONE ACRE.

	Weights used—pounds.	Nitrogen—pounds.	Phosphoric Acid.		Potash—pounds.
			Available—pounds.	Total—pounds.	
Nitrate of soda	50	8	.....	.....	.....
Acid phosphate	400	.....	52	56	.....
Muriate of potash	250	.....	.....	.....	125
Total	700	8	52	56	125
Percentage composition	.....	1.1	7.4	8.0	17.9

A SUGGESTED FORMULA (NO. 13) FOR BEANS OR PEAS WITHOUT THE MANURE ON SOIL CARRYING THE PROPER ROOT TUBERCLE ORGANISMS. FOR ONE ACRE.

	Weights used—pounds.	Nitrogen—pounds.	Phosphoric Acid. Available—pounds.	Phosphoric Acid. Total—pounds.	Potash—pounds.
Nitrate of soda	50	8	....	....	....
Acid phosphate	400	....	52	56	....
Muriate of potash	150	....	....	....	75
Total	600	8	52	56	75
Percentage composition	....	1.3	8.7	9.3	12.5

BEETS. MANGOLDS.

A crop of 600 bushels of beets carries more than 100 pounds of nitrogen, nearly 200 pounds potash, and only about 40 pounds phosphoric acid. At the Rothamsted (England) Experiment Station mangolds have been grown continuously on the same land for nearly 30 years with different fertilizers. The results of the experiments are summarized as follows:*

"Mangolds can be grown continuously on the same land without injuring the tilth of the land or the health of the crop.

"A liberal dressing of farmyard manure forms the best basis of the manure for mangolds.

"The crop will further respond to considerable additions of active nitrogenous manures to the dung, particularly of nitrate of soda.

"A free supply of potash salts is essential to the proper development of the mangold, hence a specific potash manuring is desirable, even when dung is used in large quantities, and on a strong soil initially rich in potash. When nitrogenous manures are used in addition to dung, the potash salts should be increased pro rata, in order to maintain the health and feeding value of the crop and to bring it to maturity.

* Farm Journal of Royal Agricultural Society, 1902.

"In conjunction with dung, phosphatic manure is hardly necessary and will give little appreciable return especially when the crop is grown in rotation.

"As soluble alkaline salts are beneficial to the mangold crop, either as direct foods or economizers of potash, a dressing of salt should always be included among the manures for the mangold crop."

Based upon these findings, a liberal dressing for mangolds would be about 5 cords of good stable manure and the chemicals named in the following formula.

A FORMULA (NO. 14) FOR MANGOLDS OR OTHER BEETS, BASED UPON EXPERIMENTS AT THE ROTHAMSTED (ENGLAND) EXPERIMENT STATION. TO BE USED IN CONJUNCTION WITH A LIBERAL DRESSING OF FARM MANURE. FOR ONE ACRE.

			Phosphoric Acid.		
	Weights used—pounds.	Nitrogen—pounds.	Available—pounds.	Total—pounds.	Potash—pounds.
Nitrate of soda	400	64	....	....	....
Muriate of potash	400	....	....	....	200
Common salt*	200	....	....	....	....
Total	1,000	64	....	....	200
Percentage composition	....	6.4	....	....	20

* Beets are successfully grown in Maine without salt.

This can be conveniently applied broadcast, separately. To avoid loss by leaching, only part of the nitrate of soda should be applied at planting and the remainder when the plants are well established. To use in machinery, mix with 200 to 300 pounds fine dry muck or loam.

If stable manure is not used, 40 pounds screened tankage, 400 pounds high grade dried blood (250 pounds of sulphate of ammonia can be used instead of the dried blood), and 200 pounds acid phosphate can be used to replace the manure. This formula has not been put to a practical test and is based in part upon the plant food requirements of the crop and in part upon the experience at Rothamsted.

A FORMULA (NO. 15) FOR MANGOLDS OR OTHER BEETS WITHOUT FARM MANURE. FOR ONE ACRE.

	Weights used—pounds.	Nitrogen—pounds.	Phosphoric Acid. Available—pounds.	Phosphoric Acid. Total—pounds.	Potash—pounds.
Nitrate of soda	200	32	....	....	....
Screened tankage	800	44	58	128	....
Sulphate of ammonia (or 300 lbs. high grade dried blood)	200	40	....	....	9
Acid phosphate	200	....	26	28	....
Muriate of potash	400	....	....	....	200
Common salt	200	....	....	....	....
Total	2,000	116	84	156	200
Percentage composition	....	5.8	4.2	7.8	10

FERTILIZERS IN ROTATION.

As an illustration of the use of manure and commercial fertilizers in a rotation, the following, based upon successful farm practice on rather heavy loam of retentive character, is suggestive.

First year. Potatoes on sod land.
Second year. Corn for silage.
Third year. Seeding with oats.
Fourth year. Hay.
Fifth year. Hay or pasturage.

First year. Plant with potatoes on sod land, early plowed the preceding fall and worked to a good seed bed. Apply formula No. 3, page 143 in the drill at planting. A crop of 250 to 300 bushels will have removed all the plant food of the commercial fertilizer and much of that of the sod.

Second year. Corn on stable manure and commercial fertilizer. Plow the land preceding fall. Apply the farm manure in the spring broadcast and work in with disc or other suitable harrow. Apply formula No. 4 on page 144 if 5 cords of farm manure have been used per acre, or No. 5 or No. 6 if less. A

crop of 12 to 15 tons of silage corn will have used up the nitrogen of the commercial fertilizers; part of the nitrogen of the manure and considerable phosphoric acid and potash will be left available for the next season's crop.

Third year. Seeding to grass with oats. The land is to be plowed the preceding fall. If it can be spared, topdress with about 3 cords of farm manure and use formula No. 7, page 145. If farm manure is not available, use formula No. 8, page 146. The farm manure, if used, is applied and worked in as for corn the preceding year. For grass, the land must be thoroughly worked, the surface kept true and a good seed bed prepared. Upon the heavy clay loam land at the University the following mixture has proven successful for spring seeding: Oats, 5 pecks; timothy 10 pounds; red top 7 pounds; alsike clover 6 pounds. In most seasons the grass will do better if the oats are cut green (in milk) for fodder or hay. Oat hay at best is a poor kind of hay, although if cock cured it makes a hay that will be cleanly eaten. It may be, even at the expense of the grass, best to allow the oats to ripen. Keep teams off the field as far as possible and do not turn stock into it nor cut it, even though the clover does look tempting.

Fourth year. Top dress early in the spring with 200 pounds of acid phosphate and 100 pounds of muriate of potash. As the application of nitrate of soda has a tendency to run out clover, in a five-year rotation it will be better to top dress with minerals only. If it is desired to maintain the field for hay for several years, formula No. 11, page 147 can be advantageously used. Unless there is an unusually early aftermath, do not cut a second crop or feed if the field is to be used for hay the next year.

Fifth year. Top dress as the preceding year and pasture or cut for hay.

If the preceding program is carried out with ordinary seasons, good crops should be obtained and the land should be in better fertility at the end than at the beginning, five years before.

BROWN-TAIL MOTH AND OTHER ORCHARD MOTHS.

Edith M. Patch.

It is not the well kept orchard that will serve as a shelter and breeding place for any serious pest. It is the apple tree down the lane, too old and decrepit to yield fruit, but still able to put forth leaves enough for a spring crop of bud moths and tent caterpillars, or a summer brood or two of tussock moths. It is the group of old pear trees, apparently owned by no one, with their branches hung with undersized pears cracked to the centre with scab disease, and later, when their fungus-mottled leaves fall, festooned with nests of the brown-tail moth. It is the wild cherry bushes in the back ground that show in the winter for the menace they are, when they are seen to be distorted with black knot and hung with old caterpillar webs and tents, besides being decorated by brown egg rings and white egg clusters in provision for next season's caterpillars. It is the deserted or neglected trees that are to be feared, for in them many species of caterpillars dangerous to the orchard trees breed unnoticed, perhaps for years, until they become numerous enough to make conspicuous ravages. Then one orchardist cries, "It isn't much use to try to raise apples with a new sort of caterpillar creeping in every year," and another says, "The fact is, it doesn't seem reasonable to expect a clean orchard with twenty or thirty pests lurking in the outskirts," and turns his attention to neighboring breeding places as well as to his orchard, and markets his crop in spite of the "new pest."

BROWN-TAIL MOTH. *Euproctis Chrysorrhœa.*

HISTORY (1734-1904).

European laws have been in force for one hundred and seventy years requiring land owners to destroy the winter nests of the brown-tail moths found on their trees, and this moth was described as a common pest in the earliest works on orchard insects.

About seven years ago the first outbreak of this pest occurred in Somerville and Cambridge, Massachusetts, the centre of the infested region being a florist's establishment where large numbers of shrubs had been imported from France and Holland. It is thought that the brown-tail moth was accidentally introduced upon some of these foreign plants and had become established in the vicinity before it was noticed.

Since 1899 this insect has been introduced,—probably repeatedly,—into Southern New Hampshire, where the infestation is now extended enough to cause alarm.

Five years ago the moths were captured on Cutts Island, Kittery Point * and the same season the caterpillars were reported from South Berwick where they were supposed to have been imported on rose bushes from Somerville, Mass. The colony at South Berwick was evidently destroyed and the moths on Cutts Island did not at this time continue to breed.

Late in March, 1904, Kittery was found to be badly infested, the winter nests being common in the pear trees in the village, while a few were located in wild cherry fringe on Badger's Island. Many of these winter nests were gathered and burned by the owners of infested trees and those that remained were destroyed by an expert under the direction of the State Commissioner of Agriculture, so that the ravages of the caterpillars were effectually prevented for this season.

Unfortunately, however, last July, during the time when the moths were on the wing, strong southwesterly winds occurred and the insects are reported to have appeared in great numbers

* Maine Agr. Exp. Sta. Bul. No. 61, pp. 36-39.

NOTE. The account of this insect is written with reference to Mass. Crop Report, Vol. 17, No. 3; Mass. State Board of Agriculture, Bulletin of information, The Brown-tail Moth 1898; New Hampshire College, Agr. Exp. Sta., Bul. 107; Me. Agr. Exp. Sta., Bul. No. 61. It is also a record of observations made this season at Kittery.

in Portsmouth and Kittery, the electric lights about the navy yards being the centre of attraction on the Maine side of the river.

While many of the moths were killed, without doubt enough escaped to distribute eggs all about that vicinity, and though the young caterpillars do practically no harm in the fall, there is every reason to believe that they will be present in alarming numbers another spring, unless the winter nests are removed as they were last season. Such a wholesale immigration of winged forms might never happen again, but while there is a chance of its occurring any summer, and an almost certain danger of small and less conspicuous immigrations, it is well to understand the situation and conditions about Kittery, especially in view of making it less vulnerable to orchard pests.

DESCRIPTION AND HABITS.

The moths. (Figure 27.) The moths, expanding from one and one-fourth to one and three-fourths inches, are white except for the abdomen, which is tinged with brown and tipped with a tuft of brown hairs. This tuft is small and dark in the male, but the large golden-brown tuft in the female is conspicuous enough to be the most striking characteristic of the moth, and has won for this insect its descriptive name of "brown-tail." These moths are on the wing in July, and unlike some closely related pests,* the brown-tail females as well as the males are strong fliers. They are active at night and as bright lights have an attraction for them they sometimes fly a long way toward a lighted district.

The eggs. The female usually selects a leaf near the tip of the branch, on which to deposit from one hundred and fifty to three hundred eggs. Some of the brown hairs from the abdominal tuft adhere to the egg-mass and give it the appearance of a brown felt lump. While the moths have a preference for pear trees, wild cherry, apple, and white oak prove very attractive and other trees are not scorned.

The caterpillars in the fall. By the middle of August most of the eggs are hatched and the young caterpillars spin a slight

*The weak-winged female gypsy moth and the wingless females of certain tussock moths.

web over the leaf near the egg cluster. From this protection they advance side by side, sometimes two hundred tiny caterpillars feeding in an unbroken line, though they huddle together beneath the web when disturbed in any way. When they have eaten all but the skeleton of the first leaf, they draw another into the web and repeat the process at intervals during the late summer. They feed slowly, however, and spend so much time spinning their web that they do comparatively little damage to the trees in fall, and they are still very small when cold weather comes on, those removed from the winter nests being only about one-fourth of an inch in length.

The winter nests. (Figure 19.) In the fall the young caterpillars weave additional layers of silk about their retreat, fastening it securely to the branch by the web, and pass the winter thus in colonies of one hundred and fifty to three hundred. These nests, which look like a cluster of dead leaves hanging from the branches, are readily seen after the other leaves have fallen. This is a very unusual yet most commendable habit in a caterpillar pest, for they can be killed, hundreds at a time, simply by destroying the nests in which the colonies hibernate.

The caterpillars in the spring. Early in the spring the young caterpillars emerge from their winter nests and feed upon the opening leaf buds. Until about the middle of June they feed greedily upon the leaves, completely stripping the trees where they are numerous.

When full grown the caterpillars are about one and one-half inches long. They are dark brown with a sprinkling of orange. Long fine reddish-brown hairs cover the body, and a row of conspicuous white hairs runs along each side. Like the caterpillars of the tussock and gypsy moths, they bear bright red eversible tubercles on the top of the sixth and seventh abdominal segments.

Poisonous qualities of the caterpillars. Were the caterpillars to be feared only for their ravages upon orchard and other trees, the situation would be alarming enough, but not less serious is the physical discomfort experienced by people living in infested districts. When the minutely barbed hairs of the caterpillar come in contact with the skin they cause an eruption similar to and in many cases worse than ivy poisoning. These hairs are

brittle and where the caterpillars are numerous few people are likely to escape, as the caterpillars drop from the branches and creep about, even entering houses. Direct contact with the insects themselves is not necessary, however, for when the caterpillars shed their skins, the molts are blown about widely scattering the barbed hairs. Thus in infested districts it is no uncommon occurrence for whole families to suffer from the rash caused by the hairs which settle upon clothes hung out to dry. Children gathering cherries are badly "poisoned," and near Everett, Mass., people have been obliged to leave their homes for uninfested places in order to recover from attacks of the "caterpillar itch."

"So severe is this affection that in many cases people have been made seriously ill by it. The best remedy for it is the liberal use of cooling lotions, or, what is more satisfactory, even if less pleasant, the free use of common vaseline." *

The cocoon. The caterpillars are usually full grown in June. They then spin loose cocoons, attached commonly to leaves, though sometimes other shelter is sought. Within these they transform to brown pupæ about three-fourths of an inch long. From the first to the twentieth of July the moths with pure white wings and brown-tipped abdomens emerge from these cocoons to deposit eggs for the next generation of troublesome caterpillars.

Manner of Distribution.

New localities may become infested in various ways. When startled, the caterpillars have a habit of letting themselves down from the branch and hanging by a frail silken thread. They may so swing against the clothing of a person, or drop upon a passing car or wagon and be carried long distances.

Egg laden moths may be attracted to the lights in trains and electric cars and be borne into uninfested localities before they flutter off to deposit their eggs. In New Hampshire the new localities were generally found along the lines of cars coming from badly infested regions.†

* Mass. Crop Report, Vol. 17, No. 3, p. 39.

† N. H. College Agr. Exp. Sta. Bul. 107, p. 59.

"A reliable observer, Mr. A. M. Cobb, Malden, Mass., reports that when the Bangor boat of the Eastern Steamship Line was passing some miles off Marblehead, early in July, 1904, a large swarm of the brown-tail moths came aboard and completely covered parts of the vessel." * Dr. James Fletcher, entomologist, Central Experiment Farms, Ottawa, Can., reports that a single specimen of the brown-tail moth was taken at St. John, N. B., in the summer of 1902. Such occurrences suggest the advisability of watching each fall the ports along this line for winter nests.

About the middle of July, 1904, the morning after a strong southwesterly wind, the telegraph poles and the sides of some of the buildings near the Kittery Navy Yards were reported to be white with the white-winged brown-tail moths. The town was alarmed and great numbers of the moths were washed down with hose and destroyed, but that many escaped and deposited eggs, the neighboring trees (especially the pears and wild cherries) bear abundant evidence.

Thus strong winds, lighted trains and boats, and vehicles of all sorts are seen to be among the factors which hasten the natural spread of this dreaded pest.

REMEDIAL MEASURES, DIRECT AND INDIRECT.

Destruction of certain breeding places.

The vicinity of Kittery, the entering point for the pest in Maine, is overgrown with wild cherry tangles, caterpillar-haunted † and distorted with black-knot fungus. Old and worthless trees, either fruitless or bearing scabby pears and apples, straggle neglected along the lanes and hang half dead branches over every wall. Inasmuch as such trees are a menace to the orchard interests of York county and to the State, it is desirable that they be cut down and burned. Some large and carefully tended orchards (one near Elliott yielded 1,300 barrels in 1902) which are within ten miles of the infested district should be protected against needless risks.

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* Mass. Crop Report, Vol. 17, No. 3, p. 38.

† Among the most destructive being the tent caterpillar, two species of tussock moths, the fall web worm and the brown-tail moth.

The argument for such destruction is four-fold. It is in just these trees that the winter nests would longest escape detection, it being especially difficult in a dense growth of wild cherry to ascertain whether every dangling dried leaf is attached to a winter nest. The fruit trees in question being already worse than useless, it would mean apparently a needless yearly tax, either locally or upon the State, to keep them free from brown-tail moths. There will remain enough trees worthy this attention. This remedy, though indirect, would lessen the labor of direct search for and destruction of winter nests over this ground, if not for always, yet for many years to come. Since the infested area is still comparatively small, the cost of the cutting and burning ought not to be great.

Cutting and burning the winter nests.

This is the most important of the direct remedies because it is the easiest, cheapest, and, if thoroughly done, a sufficient protection against the ravages of this pest. The webs and leaves that compose the nest are woven tightly to the tips of the branches and hang there like dead leaves all winter. With so many months for inspection there is no excuse for harboring the hibernating caterpillars on shade or orchard trees. After they are cut from the branches, the nests should be burned, as this is the simplest way of destroying the colony within.

"As showing how cheaply webs may be gathered where a general campaign is made the figures of work done by employees of gypsy moth committee in 1899 are of interest. At that time over nine hundred thousand webs were destroyed at the total outlay of nine thousand seven hundred dollars." * This would mean, accounting for the variation in the number of the caterpillars per nest, the destruction of from 15,000 to 30,000 caterpillars for each dollar's outlay.

A bounty put upon the winter nests.

Last winter in Portsmouth, N. H., the City Improvement Society placed $50 with the superintendent of schools, who paid five cents a dozen for winter nests. Hundreds of nests were brought in by the children and burned in the school furnace. In March groups of Portsmouth newsboys were to be seen scanning the branches overhead and darting off eagerly for

* Mass. Crop Report, Vol. 17, No. 3, p. 39.

"brown-tail nests." In reply to a question one bright-eyed youngster stopped long enough to say, "O we cleaned 'em all out on ——— street and then we came down here." About the same time a Kittery urchin was heard to remark somewhat wistfully, "The Portsmouth kids are makin' their fortune pickin' brown-tails."

Instruction in public schools.

It would be a simple matter to teach in an elementary way a few things about the important insects in the vicinity. A little observation and a little reading would prepare any teacher to do this. A single lesson would enable a child to distinguish the winter nest of the brown-tail moth from the webs of the fall web worm and tent caterpillar or from the various cocoons which are attached to leaves. All these things are brought into Kittery with the question "Is this the brown-tail nest?" and the fact that many people within the infested district do not know what to look for suggests the need for preparing the children of Maine to watch intelligently suspected areas for the occurrence of this pest. If nothing else were accomplished, it would be worth while to have every child know at least that the insects are not "just bugs that happen to be around," but forces of vital importance both for good and for evil in the agricultural interest of his state and nation. It seems rather a pity to leave a few such things as the relation of the white grub to the May beetle or the bumblebee to red clover, mysteries to be solved in a college course.

Spraying.

The caterpillars are readily killed by arsenical sprays. This remedy is most effective when applied as soon as the leaves develop in the spring. Of course where the winter nests have been destroyed there will be no need of this remedy and it is much easier to kill about two hundred caterpillars enclosed in a nest than to wait until they are scattered over the tree.

State Legislation.

Every state needs a statute enabling authorities to treat as common nuisances neglected property which is infested by dangerous fungus diseases or insect pests; and state appropriations should be sufficient to control conditions which are of more than local importance.

"The habit of the caterpillar in wintering over in webs at the tips of the leaves gives a key to the simplest and cheapest remedy, which is merely to cut off and burn webs during the fall, winter or spring. This preventive means is most effective, and gives such excellent results that in Germany, France and Belgium there is a law making it obligatory on property owners to destroy the webs during the winter season. Where citizens neglect to carry out this work it is done for them, and the sum thus expended added to their tax levy." *

THE GYPSY MOTH. *Porthetria dispar.* A FOREWORD.

The gypsy moth has not yet been found in Maine. The entrance of this pest, however, is probably only a matter of time. Unlike the brown-tail moth, the female gypsy moth is weak-winged and is thus unable to deposit eggs far from the cocoon from which she emerges. It is due to this in part that this moth has not yet found its way here, for it has been in eastern Massachusetts for thirty-six years and its ravages for the past sixteen years are well known.

In a district badly infested by the caterpillars of the gypsy moth no garden vegetable except the onion is safe; flowers and grass are eaten, and practically all fruit and forest trees are defoliated, pines and other coniferous trees dying as the result of a single stripping and deciduous trees not being able to withstand a three years' attack.

There is no such simple and comparatively inexpensive means of combating the gypsy moths as with the brown-tail moth, for they do not hang their colonies in plain sight all winter, but pass this season in the less conspicuous egg stage, the egg clusters being hidden in any crevice the infested area offers. These caterpillars are more resistant to poison sprays than those of the brown-tail moth and the problem is in many ways more difficult. It is the wise man who looks ahead and an additional argument for clearing out the growths which are already overrun with orchard caterpillars, (the brown-tail moth among them), is presented by the fact that southwestern Maine is the point where the first infestation of the gypsy moth would naturally occur. Nothing by way of watchfulness, instruction or

* Mass. Crop Report, Vol. 17, No. 3, p. 39.

provisional care that can be done to guard the State against these twin pests should be neglected.

"The gradual spread of the gypsy moth up to the caterpillar plague of 1888-89 is a matter of record. Equally well known is the work of the gypsy moth committee of the Massachusetts Board of Agriculture, which finally succeeded in reducing the numbers of the insect to a minimum and thoroughly controlling the pest. Since the abandonment of the state work in the early part of the year 1900, the moth has had ample opportunity to increase to a point where it is to-day more numerous, and occupying a larger area in this state, than ever before.

"Both the gypsy and brown-tail moths can be controlled by a thorough campaign over the infested municipalities. The work of the former gypsy moth committee has shown that the damage and annoyance from these pests can be practically eliminated by the application of thorough remedial measures over the entire infested districts. It is greatly to be hoped that some effort to systematically control the spread of these pests may be instituted to the end that property owners may be spared the annual visitation of the caterpillar scourge." *

Orchard Caterpillars in Wild Cherry.

In March, 1904, a wild cherry growth, just outside the district infested by the brown-tail moth, presented such strong evidence of being a common caterpillar breeding place that during the summer a few observations were made to ascertain something of the orchard pests there and whether the brown-tail moths would let another season go by without being enticed by this attractive caterpillar commonwealth. Among the insects found there, only those of importance are mentioned; and, as most of these are fully described in Apple Insects of Maine,† the general discussion is not here repeated.

ORCHARD TENT CATERPILLAR AND FOREST TENT CATERPILLAR.

Clisiocampa americana and Clisiocampa disstria.

Both these caterpillars are present. In wild growths they are commonly held in check by birds, parasites and disease. Sometimes their ravages are serious for a season or two, and a watch

* Mass. Crop Report, Vol. 17, No. 3, pp. 32 and 40.

† Me. Agr. Exp. Sta., Bul. No. 56.

has always to be kept for them in the orchard, for the colonies are large and ravenous. Orchardists are everywhere familiar with the dark brown egg-masses found upon the twigs and gather and burn them during the winter. Where these escape detection, the caterpillars can be killed in the spring by arsenical sprays. The orchard tent caterpillars construct a nest in a fork of the branches where the whole brood spends nights and cold or cloudy days. These nests, while small, are easily torn out and the colony within destroyed; or, if neglected then, the caterpillars may be killed by giving the nest a thorough soaking with kerosene early or late in the day, when the caterpillars are at home. A kerosene swab tied to a long pole is convenient for high nests. A strong alkali, whale-oil soap, or washing powder solution may be used instead of the kerosene.

FALL WEB WORM. *Hyphantria cunea.*

Another nest-building caterpillar is at present even more commonly seen in this vicinity than the tent caterpillar. Their unsightly webs are stretched in every neglected orchard and the cherry tangle is full of them. These nests are made much later in the season than those of the tent caterpillars and are easily distinguished from them, as they are looser structures and very irregular, being woven over all the leaves which the brood feeds upon. Arsenical sprays on the leaves near the nest poison the supply next to be enclosed by the web, and the caterpillars feeding upon them are killed. Sometimes, however, the webs are discovered too late in the season for poisons to be used on bearing trees. Usually the nests are so situated on the branches that while still small they can easily be removed and destroyed. Kerosene or strong alkaline applications can be made as with the tent caterpillars.

There is no need of confusing the nests of tent caterpillars or fall web worms with those of the brown-tail moth, as the greater size and looser texture of these ungainly webs are distinctive marks. Moreover, unlike those of the brown-tail moth, they contain no living caterpillars in the winter.

WHITE-MARKED TUSSOCK MOTH. *Notolophus (Orgyia) leucostigma.*

OLD TUSSOCK MOTH. *Notolophus antiqua.*

WELL-MARKED TUSSOCK MOTH. *Notolophus definita.*

The moths of this Notolophus group are closely related to the gypsy and brown-tail moths. The caterpillars resemble these two pests in having bright red tubercles on the sixth and seventh abdominal segments. The female moths are wingless and usually cling to the cocoons from which they emerge and deposit their egg clusters there. They winter in the egg stage and where they are numerous, the white, rather conspicuous egg clusters (figure 24) are gathered and burned during the winter. The caterpillars may be killed in the spring by arsenical sprays.

Caterpillars of all three species were collected in Maine this summer, the white-marked and the old tussock moths (figure 25) being common in the orchards and cherry growths at Kittery.

The white-marked tussock moth has proven a serious pest in several New England cities. For the last few years Portland has been especially troubled by them. Not long since the park board had the egg-laden cocoons gathered "by bushels" and destroyed. The same proposition faces them this year, for many of the tree trunks along the Western Promenade and vicinity are lined with this season's cocoons, the egg supply on some of the young elms being great enough to forbode defoliated trees in the spring.

HICKORY TIGER-MOTH. *Halisidota caryæ.*

This shaggy black and white caterpillar (figure 23) which grows to nearly an inch and one-half in length does not confine itself to hickory but is commonly seen late in summer feeding freely on many trees, the wild cherry and apple among them.

RED-HUMPED CATERPILLAR. *Œdemasia concinna.*

More of these have been sent to the Station this summer than any other insect. The caterpillars (figure 26) are striking in appearance having fine longitudinal stripes of black, white and

yellow; bright red heads, with a humped first abdominal segment to match; and short black spines arranged in rows. The broods are gregarious and if found while the caterpillars are young, the whole colony can frequently be removed with a small branch on which they are clustered, and destroyed. By jarring the branch they can be brought to the ground and killed there. Arsenical sprays will kill them, but as the caterpillars occur from July to October, the presence of ripe fruit often debars the use of poison.

These caterpillars were reported this season from Skowhegan, Farmington, Dexter, Eliot, Kittery, Sebago Lake, Turner, Wiscasset and Orono. Hymenopterous parasites were bred from all the specimens received from Eliot, but none of the caterpillars from the other places were attacked, although they were nearly full grown at the time they were collected.

PROMETHEA MOTH. *Callosamia promethea.*

CECROPIA MOTH. *Samia cecropia.*

These two large and beautiful moths are included, not because they seem likely to do much harm in the State, but because their cocoons, found upon trees in the winter, are frequently mistaken for the winter nests of the brown-tail moth. Figures 20, 21, and 22.

Fifty-three promethea cocoons, gathered from wild cherry and barberry bushes, were brought into Kittery last March for brown-tail moth nests. The collector, a bright little lad, was told that each contained a single brown object which would change to a large moth in the spring, and not a lot of little caterpillars such as the winter nests held. "But," he protested "I *did* open one and there was *not* just one big thing in it, but a whole lot of little ones." A second cocoon opened in his presence revealed, indeed, not a single brown pupa, but nineteen tightly packed cells, each containing the pupa of a Hymenopterous parasite. Only nine of the fifty-three cocoons yielded moths. All the rest were parasited,—twenty-two red and black Ichneumon flies emerging from a single cocoon which had been placed alone in a glass. Evidently there is no immediate danger from the promethea moth!

The cocoons of the closely related species, the cecropia moth, are frequently sent in, but the fact that they are usually accompanied by the explanation that "only one was found in the orchard," indicates that they, also, are held in check by natural enemies.

In concluding the list of orchard pests found in cherry growths in the vicinity of Kittery it may be well to state that the observations made were neither frequent nor exhaustive. Other important caterpillars, for example those of the bud moth,* might easily have grown there undetected, for the vicinity was not visited during the time they are at work.

The brown-tail moth was not found in the cherry tangle selected in March, but the succeeding generation was found to be established there in August.

Perhaps in this connection people who have sent orchard insects to the Station may be interested to know that all the living apple-leaf-eating caterpillars, which were received this season, together with what different species were found about Orono, were reared on wild cherry leaves. This was done simply as an illustration of a well known fact, and is significant only where orchards are supplied with pests from neighboring cherry growths.

Some Birds that Feed on Orchard Pests.

When a few particular species of insects become sufficiently numerous to be considered pests and artificial means for controlling them are required, the question is always suggested: How does it happen that the closely related insects just as prolific, just as ravenous, and with similar habits, do not also overrun the orchards? An answer is found in the fact that there are enough natural enemies (as birds, parasites and disease) to hold in check many insects which would otherwise call forth arsenical sprays or other artificial remedies. The fact is not always appreciated, however, that these co-workers, even where they fail to hold some particular insect in check, lessen the labor of man in his battle of spraying machines and other appliances against even the most troublesome species. The woodpecker for instance, pulls out more borers each year than man is able to destroy with knife and wire, yet this bird is not always wel-

* *Tmetocera Ocellana.*

comed to the orchard. It is purposed merely to mention here a few birds that destroy great numbers of insects, the orchard caterpillars discussed in this bulletin among them. The passages which follow are quoted from the popular and valuable Farmers' Bulletin No. 54, "Some common birds in their relation to agriculture."

"While it has long been known that birds play an important part in relation to agriculture, there seems to be a tendency to dwell on the harm they do rather than on the good. * * * The practical value of birds in controlling insect pests should be more generally recognized. It may be an easy matter to exterminate the birds in an orchard or grain field, but it is an extremely difficult one to control the insect pests. * * * If birds are protected and encouraged to nest about the farm and garden, they will do their share in destroying noxious insects. * * * A few hours spent in putting up boxes for bluebirds, martins, and wrens will prove a good investment. In many states birds are protected by law. It remains for agriculturists to see that the laws are observed.

"About 14 per cent of the quail's food for the year consists of animal matter (insects and their allies). Prominent among these are the Colorado potato beetle, the striped squash beetle, the cotton boll weevil, the chinch bug, grasshoppers, cutworms, and other pests of agriculture. * * * An examination of the stomachs of 46 black-billed cuckoos, taken during the summer months, showed the remains of 906 caterpillars, 44 beetles, 96 grasshoppers, 100 sawflies, 30 stink bugs, and 15 spiders. In all probability more individuals than these were represented, but their remains were too badly broken for recognition. Most of the caterpillars were hairy, and many of them belonged to a genus that lives in colonies and feeds on the leaves of trees, including the apple tree. One stomach was filled with larvæ of a caterpillar belonging to the same genus as the tent caterpillar, while others contained that species. * * * From two-thirds to three-fourths of the food of two common woodpeckers consists of insects, chiefly noxious. Wood-boring beetles, both adults and larvæ, are conspicuous, and with them are associated many caterpillars, mostly species that burrow into trees. * * * It is estimated that the 87 stomachs of night hawks examined contained not less than 20,000 ants; and these were not half of

the insect contents. * * * The insects that constitute the great bulk of the food of the king bird are noxious species, largely beetles—May beetles, click beetles (the larvæ of which are known as wire worms), weevils, which prey upon fruit and grain, and a host of others. * * * There is hardly a more useful species about the farm than the phœbe, and it should receive every encouragement. * * * In his insect food the crow makes amends for his sins in the rest of his dietary. * * * June bugs, and others of the same family constitute the principal food during spring and early summer, and are fed to the young in immense quantities. * * * Grasshoppers are first taken in May, but not in large numbers until August, when, as might be expected, they form the leading article of diet. This shows that the crow is no exception to the general rule that most birds subsist, to a large extent, upon grasshoppers in the month of August. * * * May is the month when the dreaded cutworm begins its deadly career, and then the meadow-lark does some of its best work. * * * Observation both in the field and laboratory shows that caterpillars constitute the largest item of the fare of the oriole."

Among the other insect-eating birds discussed in this same bulletin are the mourning dove, the jays, the bobolink, the black birds, the sparrows, the grosbeaks, the swallows, the cedarbird, the catbird, the brown thrasher, the chickadee (that does much good by eating the eggs of tent caterpillars), and the robin.

"The Baltimore oriole and the English sparrow have been seen feeding upon the caterpillars of the brown-tail moth and the latter bird also attacks the moths." *

"Thirty-eight species of birds have been identified when feeding upon the gypsy moth in one or more of its forms." †

* Mass. State Board of Agriculture. Bulletin of Information. The Brown-tail Moth. 1898.

† Mass. Board of Agriculture. The Gypsy Moth. 1896.

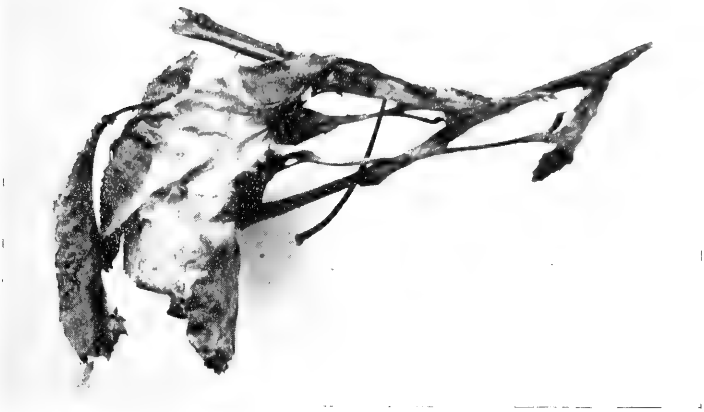

Fig. 19. Winter nest of brown-tail moth, collected at Kittery, March 30, 1904.

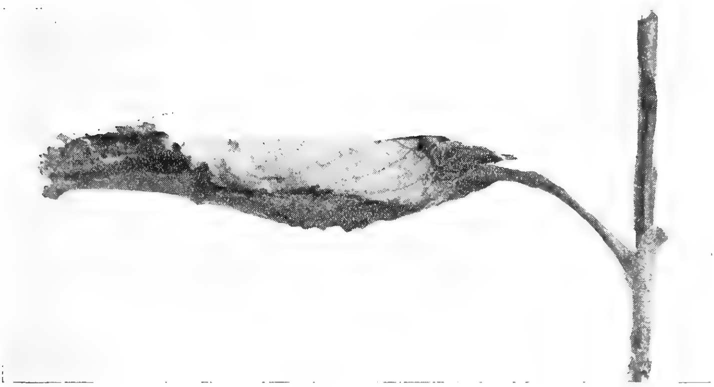

Fig. 20. Cocoon of promethea moth, collected at Kittery, March 30, 1904.

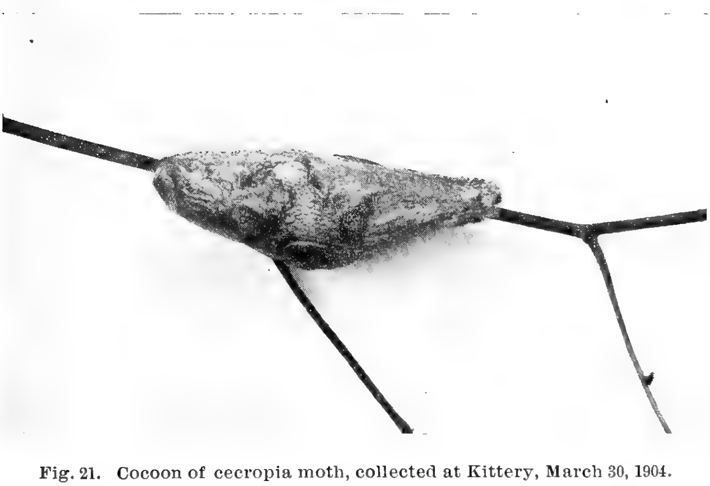

Fig. 21. Cocoon of cecropia moth, collected at Kittery, March 30, 1904.

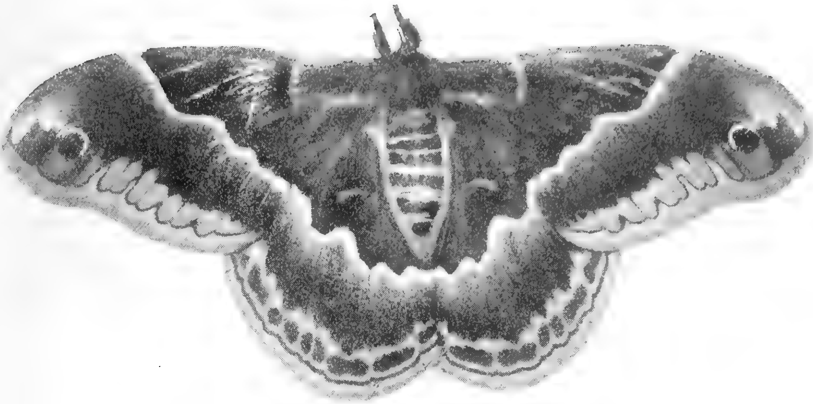

Fig. 22. Promethea moth. Female.

Fig. 23. Caterpillar of hickory tiger moth, collected at Kittery, Aug. 22, 1904.

Fig. 24 Cocoon of old tussock moth covered with eggs, collected at Kittery, March 30, 1904.

Fig. 25. One of the caterpillars that hatched from the eggs shown in the accompanying figure.

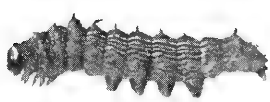

Fig. 26. Red-humped caterpillar.

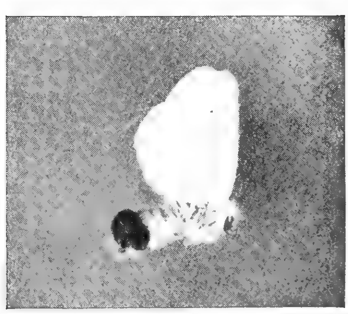

Fig. 27. Brown-tail moth. Female.

THE APPLE MAGGOT (*Rhagoletis pomonella.*)

EDITH M. PATCH AND W. M. MUNSON.

In acknowledgement of, if not in answer to, the appeals for help against the apple maggot, a consideration of this insect seems again to be due. The life history of the apple maggot is well enough ascertained so that the fight against it can be intelligently carried on; and an attempt has been made in this paper simply to bring together such known facts in the life of the pest as have a bearing on the means of combating it. The statements are based in the main upon the investigations recorded in the Monograph on The Apple Maggot (1888-1889) by the late Professor F. L. Harvey.* Independent observations of the advanced larval and early pupal stages have been made, but inasmuch as they serve merely to confirm what has already been done, they are for the most part suppressed.

It has not seemed necessary to restate the detailed work which led to a knowledge of the facts here given. Fifteen years have not brought about any apparent change in the insect. When it was first described for Maine, the apple maggot preferred the softer fall varieties, but was capable of developing in hard winter ones; and it has lost meanwhile neither the preference nor the capability. The apple maggot has of late changed its generic name, but since the transformation has not entered into the nature of the pest, the same things which were true for *Trypeta pomonella* still hold for *Rhagoletis pomonella.*

DESCRIPTION.

Egg.

The light yellow eggs are fusiform and about four times as long as broad, measuring in length from .8 to .9 mm. and in breadth about .2 mm. At the end left nearest the surface of the apple, the egg has a little stalk or pedicel. The ovaries fill most of the abdominal cavity of the female fly. Each side contains twenty-four chains of eggs, each chain having at least seven eggs in different stages of development.

* Report this station for 1889, pp. 190-241.

Larva.

The footless maggot is opaque whitish, with a greenish or more often a yellowish tint. It measures from 7 to 8 mm. in length and is 2 mm. or slghtly less in breadth. The body is composed of fourteen segments, the ninth, tenth and eleventh being the thickest. From the ninth segment the body slopes anteriorly to the pointed retractile head segments. The posterior end is much broader than the anterior and is squarely cut off.

The head end is easily distinguished both on account of its pointed shape and the presence of the dark chitinous jaws, which are hook shaped and serve to dig the tunnels and soften the pulp about the larva. The three anterior segments may be retracted, hiding the hooks. See Fig. 31.

The tracheal system is well developed. Anteriorly there are two ventrodorsal tubercles between the third and fourth segments, the cephalic spiracles. Leading from each of these to a caudal spiracle on the fourteenth segment is a lateral tracheal tube. Between the fourth and fifth segments and the eleventh and twelfth segments, the lateral tracheæ are connected by branch tubes.

Pupa.

In this stage the insect is pale yellowish brown in color and oval in shape. It measures about 4.2 to 5.2 mm. in length and is about half as broad. The pupa remains within the larval skin, which becomes thicker and darker. The pupæ are variable in size, the larger ones being quite possibly the females. Fig. 32.

Fly (female).

The adult female is about 5.8 mm. in length with a wing expanse of 12.15 mm. The head is light brown or pale rusty red. The prominent eyes are green with reddish and steel-blue reflections. The antennae are three jointed, the proximal joint being shortest; the second having numerous short thick black bristles on the inner face; and the distal joint long, rounded at the tip. The mouth parts are pale yellow. The thorax is black, striped with silverv longitudinal lines, and marked with a dorsal white spot. The wings are broad and clear at the base. Four dark cross bands traverse each wing. The margin of the wing is armed with bristles. The legs are yellowish and black, and

the feet are clothed with dark hairs. The abdomen is composed of seven segments, black as to ground color and striped with four white transverse bands. The seventh segment is blunt when the sheath and ovipositor are retracted, but sloping when the sheath is protruded. The ovipositor is brownish, hornlike above, and bears a median groove below which is covered by two flaps, from beneath which the eggs escape. The ovipositor is sharply pointed and somewhat curved at the end. Fig. 30.

Fly (male).

The adult male is smaller than the female, but of the same general color. The abdomen is composed of but five segments and has only three white bands upon it.

LIFE HISTORY.

The flies, a little smaller than the house-fly and readily distinguished by four dark irregular bands across the wings, are found in the apple orchards from about July first until frost. During this time the females are employed laying eggs, by piercing the skin of the apple with a sting-like ovipositor and leaving at each incision one egg buried in the pulp. Each female is capable of laying at least three or four hundred eggs.

From the eggs hatch apple maggots which tunnel through the pulp where they feed until full grown. Often their tunnels lie directly beneath the skin of the apple, showing through in the light colored varieties as dark trailing tracks which have won for the apple maggot the popular name of Railroad Worm. (See fig. 28). But, though the maggot frequently comes near the surface of the apple, it never breaks through the skin and is thus always protected, a circumstance which shows clearly that it is of no use to try to destroy this pest by spraying.

When the eggs are laid, the apples are young and hard and for some time the maggots grow very slowly. At this stage the tunnels are very inconspicuous and the maggots themselves are not likely to be detected except by careful search. As the apple matures, the maggot makes more and more headway and is frequently full grown by the time the apple is ripe. Moreover the presence of the maggots seem to hasten the development of the apples and much of the infested fruit comes to the ground as windfalls. This is the reason so much stress is laid on the destruction of windfalls to get rid of the maggot.

Since the flies are so long on the wing and lay their eggs over such an extended time, the full grown maggots are found at different periods. The first eggs are laid naturally in the early fruit and accordingly as soon as August tenth full grown maggots have been recorded in Early Harvests. On the other hand, some of the later maggots, from eggs laid in harder winter varieties, do not acquire their full size until late in the fall or winter. These are the maggots that are stored with the fruit.

So far as has been observed the maggots are never mature enough to leave the apples before the fruit falls, but the full grown maggots (shown in fig. 31) bore out of the windfalls and bury themselves an inch or less in the ground. Or, if they are in gathered fruit where they cannot find a suitable burying ground, they creep away beneath some protecting object instead. Soon after leaving the apple (sometimes the transformation takes place within the apple but not often) the maggots shrink a little in length and bulge a little in thickness, the skin at the same time growing tougher and slightly darker.

The insect is known in this form (fig. 32) as the pupa, and rests in this stage all winter. With the return of summer a second transformation takes place which is complete when a fly (fig. 30) with banded wings breaks out of the tough skin which has covered the pupa all winter and comes from its hiding place to seek an orchard where it may spend its life laying eggs in the pulp of young apples.

PREVENTATIVE MEASURES.

As pointed out here, it is useless to try to poison the growing maggots as they are within and protected by the apple. It is also evident that if the maggots contained in windfalls and picked fruit are destroyed one year there will be no trouble to fear from them the next. Of course it is highly improbable that even by the greatest vigilance, every maggot could be thus destroyed. But when it is considered that each maggot left to its own devices has a chance of becoming a fly capable of laying at least three hundred eggs, and that each maggot undestroyed this year may mean three or four hundred next year, the importance of killing as many as possible is evident. If the apple maggots, as do many insects, all developed about the same time, the problem would be much simpler, but as full grown maggots

are found in apples from before the middle of August until into the winter, the watch for them must extend over several months.

If enough hogs or sheep to eat the windfalls are kept under infested trees from the second week in August until the fruit is finally gathered, all the maggots in windfalls will be got rid of. Of course the same results, as far as destroying the maggot is concerned, can be obtained by having windfalls faithfully gathered during this time and fed to stock, or made into cider. In some localities the entire orchard will be involved and the task will be a hard and wearisome one, but in many places, where only a few trees are infested, the maggots can be destroyed with comparatively little labor.

Many maggots may be found in fruit at canning time. Here the housewife can help the orchardist by burning infested refuse or killing the maggots with boiling water. Where chickens are kept, the parings can be thrown to them, for they will see that no creeping thing escapes.

Stored fruit remains to be considered. If this is kept in closed boxes or barrels the maggots cannot escape, but will stay in the bottom and enter the pupa state there. As each box is emptied of the fruit, the litter at the bottom in which the little brownish pupæ remain should be carefully poured out and burned.

Another question is, what is to be done with infested fruit on the market? Growers and wholesale dealers can do much to prevent increase of the apple maggot by destroying fruit too much infested to be sold or by giving it to some one with stock. Dealers will not appreciate the danger so much as growers themselves and it would doubtless pay orchardists to explain to dealers in their vicinity the danger from infested fruit and to make some arrangement for disposing of it.

With the home-grown maggots put out of the way, we have still to consider the immigrants coming from other states. Badly infested fruit is imported. It would seem to be well worth while for the State of Maine to prevent this by enacting a law, prohibiting importation of infested apples, with an appropriation sufficient to insure at each entrance port the inspection of imported fruit, at least of the early varieties from which most is to be feared.

The fight against the apple maggot, while exceedingly tedious, is not more difficult than that against many other insect pests. It is useless to wait for simpler or easier methods. Sprays may

reach the codling moth before the larva enters the fruit, but the apple maggot is inside the fruit from the very beginning and is safe from poisons. Again, after the maggot buries itself in the ground it is practically safe, as there is great difficulty in fighting under ground insects. But there is a chance to kill it in the fallen fruit and it must be attacked, if at all, at this its one vulnerable point. The way once made plain, the situation is in the hands of the fruit growers, so far as home orchards are concerned, and in the hands of the State as regards imported fruit.

Since this method of destroying the apple maggot was recommended, some ten or twelve years ago, it has been tried in different parts of the State. In this connection it is interesting to note what a few of the fruit growers of Maine have to say from their experience.

One fruit grower in Androscoggin county who keeps hogs or sheep under most of his trees and picks up the rest of the windfalls, met with a loss from the apple maggot this year of about one per cent of his crop. Another in the same county has picked windfalls carefully and states that the trouble from the apple maggot has decreased the past two years, and he experienced no loss from the pest this year. A third man in Androscoggin county says that he does nothing whatever to prevent the ravages of this pest and reports this present year a considerable loss from the apple maggot. He does not pick up his windfalls, nor does he pasture sheep or hogs in his orchard.

From Cumberland county one orchardist reports less injury for the past two years and thinks it is the result, to a great extent if not entirely, of having the windfalls taken care of as soon as they fall from the tree. He pastures with hogs, sheep, geese, and hens. Another orchard owner in the same county does not keep sheep or hogs under his trees and does not pick up his windfalls. He reports the loss of about one-fifth of his crop this year. He states his belief that hogs or sheep enough to take care of the windfalls would prevent the ravages.

One fruit grower in Franklin county who pastures sheep in his orchard and another who keeps hogs under his trees both state that their loss has been very small this year.

A Kennebec county orchardist says the last few years the apple maggot has not been so bad. He pastures sheep in part of the orchard and keeps his apples picked up. A second man

from Kennebec county picks up his windfalls and reports that there has been no loss this present year with him.

An orchardist from Sagadahoc county states that he picks up the windfalls and that ravages are decreasing. This year he met with no loss from the pest.

From Lincoln county one fruit grower states that there was no money loss from the apple maggot with him this year. He gathers his windfalls every day. A second man from Lincoln county who keeps hogs under his trees says the maggots did less injury this year than any other year since they first appeared.

Of two Penobscot fruit growers who do not take care of their windfalls, one reports a great loss from the maggot and the other a loss of five per cent of his crop. A third man from the same county picks up his windfalls as soon as they fall. This year he had hardly any loss.

An apple grower in Somerset county says that the apple maggot is not increasing as fast with him as in many places and thinks sheep running under the trees keep the pest down to a great extent.

From Washington county a report comes from an orchardist who has not seen any maggots this year, nor can he find on inquiry any one who has. He gathers his windfalls every day and says it is the common practice in that vicinity to gather windfalls carefully and feed them. Several keep hogs in the orchard.

An apple grower in Aroostook county says he has never seen any maggots in apples grown there.

An orchardist in Piscataquis county says the maggot seemed to increase the last four or five years until this year when he met with practically no loss. He keeps the windfalls from early varieties carefully picked.

With one exception all the fruit growers just quoted feed the refuse from stored apples to stock or to poultry.

Besides the foregoing specific statements it remains to be said that some orchardists who have not made a practice of caring for their windfalls have met with but slight loss from the maggot this year. The question naturally arises, are they feeling the influence of neighboring orchards which are tended?

On the other hand, a few apple growers say they have put the fallen fruit out of the way and yet do not find the trouble

decreasing. One of these, however, makes the suggestive remark that the windfalls in neighboring orchards are left on the ground.

It is impossible to ascertain the exact effect, if any, of climatic conditions upon the question. Even if it were possible, the knowledge would probably not prove helpful, for there could be no control of natural climatic conditions on a scale sufficiently large to control this pest.

All things considered, it seems perfectly justifiable to conclude that those orchardists from all parts of the State who have said —"We destroy the windfalls and the trouble is decreasing with us"—have answered their own question as to what shall be done with the apple maggot.

From many counties the reports concerning the varieties damaged came in general terms, indicating that nearly all sweet fall apples and mild sour ones are troubled more than the hard winter fruit.

Although the lists on pages 177 and 178 are not at all complete, perhaps they will not be altogether devoid of interest. They indicate that while in some orchards even the most susceptible varieties may escape infestation, the maggot is capable of adapting itself to most kinds of apples and that there is no certainty that any variety is safe until the orchardist is sure that hundreds of maggots are not burying themselves in his orchard every fall.

The plate facing this page shows, in figure 28, apples with characteristic larval trails which give rise to the popular name, "railroad worm." Figure 29 shows, in cross section of apples, the advanced work of the maggots. Figures 30, 31, 32, represent three stages of the apple maggot—the fly, the larva, and the pupa, all enlarged.

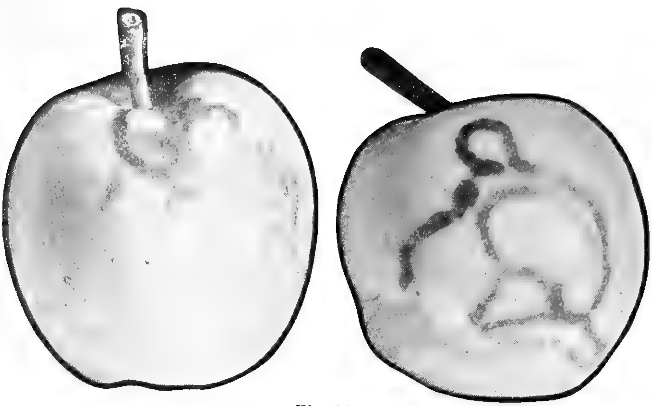

Fig. 28.

Fig. 29

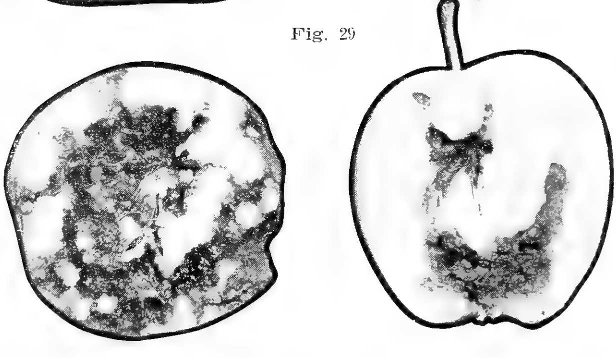

Fig. 31.

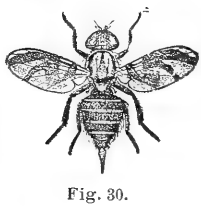

Fig. 30.

Fig. 32.

The apple maggot and its work.

APPLES REPORTED TO HAVE BEEN INFESTED BY THE APPLE MAGGOT.

A * against the county indicates that the variety named has been badly infested in that locality.

Variety.	County.
1. August Sweet	Oxford*.
2. Bailey Sweet	Cumberland.
3. Baldwin	Penobscot*, Androscoggin, Franklin.
4. Bellflower	Kennebec, Androscoggin.
5. Deane	Piscataquis, Lincoln*.
6. Duchess (Oldenburg)	Lincoln*.
7. Early Harvest	Franklin*, Cumberland, Androscoggin.
8. Fameuse	Piscataquis, Lincoln, Franklin, Penobscot*, Kennebec, Oxford*, Cumberland, Androscoggin*.
9. Foundling	Lincoln*.
10. Franklin Sweet	Kennebec.
11. Gravenstein	Penobscot, Androscoggin, Lincoln, Kennebec, Oxford, Cumberland.
12. Granite Beauty	Lincoln.
13. Garden Royal	Somerset, Lincoln*, Franklin, Cumberland.
14. Garden Sweet	Kennebec*.
15. Golden Sweet	Cumberland.
16. Haskell Sweet	Sagadahoc.
17. Harvey	Franklin, Oxford, Androscoggin.
18. Hightop Sweet	Sagadahoc.
19. Hubbardston	Sagadahoc.
20. Hurlbut	Lincoln.
21. Jewett's Red (Nodhead)	Lincoln, Sagadahoc*, Oxford, Piscataquis, Penobscot*, Kennebec*, Franklin, Cumberland.
22. King (Tompkins)	Kennebec, Penobscot*.
23. Kings Graft	Lincoln*.
24. King Sweet	Somerset*, Lincoln*, Kennebec*, Cumberland.
25. Ladies Sweet	Cumberland.
26. McIntosh	Penobscot *, Lincoln*, Oxford.
27. Milding	Lincoln, Franklin*.
28. Minister	Sagadahoc.
29. Moody	Androscoggin.*.
30. Munson Sweet	Lincoln*, Cumberland*.
31. Northren Spy	Kennebec, Sagadahoc*, Lincoln, Somerset, Androscoggin, Oxford*, Franklin.
32. New York Pippin	Kennebec.
33. Orange Sweet	Lincoln*.
34. Peach	Cumberland.
35. Pearmain (Summer)	Kennebec*, Cumberland.
36. Porter	Kennebec, Sagadahoc, Franklin*, Cumberland, Androscoggin*.
37. Pound Sweet	Cumberland.
38. President	Androscoggin.
39. Primate	Kennebec*.
40. Pumpkin Sweet	Cumberland.
41. Red Astrachan	Kennebec, Androscoggin, Cumberland, Sagadahoc, Piscataquis.
42. Ribstone	Penobscot.
43. R. I. Greening	Androscoggin, Oxford.
44. Rolfe	Piscataquis, Somerset, Penobscot*.
45. Sherwood Favorite	Cumberland.
46. Spice Sweet	Kennebec.
47. Spitzenburg	Oxford.
48. Sops of Wine	Cumberland.
49. Superb Sweet	Androscoggin.
50. Sweet Bough	Kennebec*, Oxford*, Cumberland*, Androscoggin.
51. Tallman Sweet	Sagadahoc*, Kennebec*, Somerset, Penobscot, Lincoln*, Androscoggin, Franklin, Oxford*, Cumberland*.
52. Twenty Ounce	Lincoln, Somerset, Kennebec, Cumberland.
53. Wealthy	Penobscot, Lincoln,
54. Winthrop Greening	Kennebec.
55. Williams Favorite	Cumberland.
56. Yellow Transparent	Cumberland.
57. Benoni	Cumberland.

FRUIT REPORTED TO BE FREE FROM THE APPLE MAGGOT, OR ONLY SLIGHTLY ATTACKED, IN SOME ORCHARDS IN THE COUNTIES NAMED.

Variety.	County.
Baldwin	Cumberland, Piscataquis, Sagadahoc, Penobscot, Oxford, Androscoggin, Franklin, Kennebec, Lincoln.
Beauty of Kent	Lincoln.
Ben Davis	Penobscot, Oxford, Lincoln, Kennebec, Somerset, Androscoggin, Franklin.
Benton Red	Penobscot.
Bellflower	Sagadahoc, Cumberland, Androscoggin, Kennebec, Oxford, Somerset, Lincoln.
Black Oxford	Sagadahoc, Penobscot, Androscoggin, Lincoln, Kennebec.
Blue Pearmain	Lincoln.
Danvers Winter Sweet	Lincoln.
English Russett	Lincoln.
Fallawater	Piscataquis.
Gano	Kennebec.
Gravenstein	Lincoln.
Grimes Golden	Lincoln.
Haas	Penobscot, Lincoln.
Harvey	Sagadahoc, Kennebec.
Hubbardston	Androscoggin, Kennebec.
Hunt Russett	Lincoln.
Jewett's Red (Nodhead)	Kennebec, Oxford.
King (Tompkins)	Piscataquis, Sagadahoc, Cumberland, Kennebec, Oxford.
Ladies Sweet	Lincoln.
Maiden Blush	Androscoggin.
Mann	Somerset, Penobscot.
McIntosh Red	Oxford, Androscoggin.
Milding	Piscataquis, Lincoln.
Newtown Pippin	Lincoln.
Northern Spy	Piscataquis, Penobscot, Kennebec.
Porter	Lincoln, Kennebec.
Red Astrachan	Kennebec, Somerset.
Red Canada	Kennebec.
Red Russett	Kennebec.
Rhode Island Greening	Piscataquis, Sagadahoc, Penobscot, Kennebec, Androscoggin, Lincoln, Somerset, Cumberland, Oxford.
Rolfe	Androscoggin.
Roxbury Russett	Kennebec, Somerset.
Russett	Sagadahoc, Penobscot, Androscoggin, Oxford, Lincoln, Kennebec, Franklin.
Spitzenburg	Sagadahoc, Lincoln, Somerset.
Stark	Piscataquis, Penobscot, Franklin, Kennebec, Lincoln, Somerset.
Starkey	Lincoln.
Tallman Sweet	Lincoln.
Wagener	Penobscot, Androscoggin, Lincoln.
Wealthy	Sagadahoc.
Westfield (Seek-no-Further)	Androscoggin.

INSECT NOTES FOR 1904.

EDITH M. PATCH.

The situation for this year is marked especially by an immigration of brown-tail moths, *Euproctis chrysorrhœa*, to the southern part of the State in July; the reappearance of the white-marked tussock moth, *Notolophus leucostigma,* in the shade trees of Portland; the occurrence of the red-humped caterpillar, *Œdemasia concinna,* in all parts of the State; a conspicuous outbreak of the cottony grass-scale, *Eriopeltis festucæ,* in many localities; and a general infestation of aphids.

Just the right conditions (whatever they may be) have existed for aphids this summer. From April to November black alders have been white stemmed with *Schizoneura tessellata* as shown in fig. 33. About the middle of July the maples along the Penobscot were clustered thick upon leaves and leaf stems with aphids of the same genus, and the river two miles above Old Town had a milky white cast caused by the bodies and molts. In June whole hillsides were sticky with honey dew, the coniferous trees present being covered with aphids which for the most part belonged to the genus *Lachnus.* The leaves of apple, elm highbush cranberry, snowball, and currant are among those which were especially attacked. *Chermes pinicorticis* was conspicuous in some localities on white pine. Perhaps the most interesting of the gall producing aphids present is a species of Chermes which is distorting the branches of the Norway and red spruces in eastern Maine. The open cone-like gall of this aphis is shown in fig. 34.

As would be expected, numbers of insects were attendant upon the aphis colonies. Five species of fireflys, *Lampyridæ,* were common upon infested bushes in June; the first of July lace-winged flies, *Chrysopidæ,* were shyly darting about the woods while their progeny of aphis lions were ravaging colonies of plant lice; all through the season striped syrphus flies (fig. 37) could be seen hovering about and their larvæ (fig. 36) could be found everywhere waxing fat in aphis clusters; the lady beetles were not so numerous as might be wished, though eight species were taken at Orono in May and June. Of the insects which

were attracted by the honey dew, ants were present in the usual numbers; and in August three species of yellow jackets were very numerous about the leaves and upon the ground under those species of aphids which secreted most honey dew.

The larvæ of a drone fly, *Eristalis tenax,* is never found without arousing curiosity. Fig. 46 will show why it is called the rat-tailed larva. This maggot lives in such places as cesspools, and the "tail" is really an extended breathing tube the tip of which the insect elevates into the air and is so able to breathe, although the rest of its body is buried in fluid matter. The adult insect frequents flowers.

The willow cone gall, shown in fig. 43, is another common object concerning which questions are often asked. This gall is caused by a gnat, *Cecidomyia strobiloides,* about the size of a mosquito, which deposits an egg in the willow buds early in the spring. The subsequent growth of the willow leaves is abnormal and they cluster into a close cone-like object, in the heart of which is a larvel cell (fig. 42) containing the yellowish pink maggot. Here the insect passes the winter, and the adult gnat emerges at the time the willows are budding, about the middle of May here in Orono.

Robber flies, *Asilidæ,* are frequently brought to the station, their queer shape or peculiar manner attracting attention. Two were found this summer preying upon the cabbage butterfly, *Pieris rapæ,* (see fig. 39) and their rapacious appetite leads to the destruction of many insects, the honey bee among them, a fact not enjoyed by bee keepers.

Among the most important natural factors in helping to keep injurious insects within bounds are the ichneumon flies. Although the various species differ in size and color, fig. 38 will serve to illustrate the characteristic form of many of these beneficial insects.

The slow-flying Pelecinus, fig. 35, has been common enough to cause considerable inquiry. No detailed studies have been recorded, but it is reported to be parasitic upon the white grub, fig. 45, the young May beetle, fig. 44.

Other insects important in the economy of nature are the numerous carrion beetles that dispose of decaying flesh which they find in fields and woods. Fig. 41 represents one large genus, *Silpha,* of these scavengers.

The beautiful maple borer, *Plaginotus speciosus,* fig. 40, was received from Monmouth the middle of July. The insect lays its eggs about this time in the bark of hard maples and the larvæ bore into the wood. Their presence is made known in the spring by the dust that is pushed from their tunnels, and the borers can be destroyed by a knife and a wire, as in the case of the apple tree borers.

During the year a number of insects have been received from correspondents for identification. A list of these with notes is given in the following table. In addition to these, a few other animals have been received and examined. These include: Nematode worms, from salt cod fish. The flesh bordering the alimentary canal was filled with encysted worms, which were more than an inch in length. Millipedes. Numerous in a cucumber house at York Corner, where they spoiled most of the cucumbers. Trap door spider, *Theraphosidæ.* Received from Levant, though evidently a southern species.

INSECTS RECEIVED FOR IDENTIFICATION.

Name.	Date.		Host.	Locality.	Remarks.
Cecropia moth, *Samia cecropia*	March	20	Apple	Madison	Cocoon, "only one seen."
Cecropia moth, *Samia cecropia*	March	29	Apple	Kittery	Cocoon, only one seen in orchard.
Cecropia moth, *Samia cecropia*	April	1	Apple	Caribou	Cocoon, four on one tree "not seen before."
Cecropia moth, *Samia cecropia*	May	9	Apple	South Presque Isle	Cocoon, "only one found."
Promethea moth, *Callosamia promethea*	March	30	Wild cherry and barberry	Kittery	Cocoon numerous, mostly parasited.
Old tussock moth, *Notolophus antiqua*	June	14	Apple	Lewiston	Larvæ.
Old tussock moth, *Notolophus antiqua*	March	29	Apple	Kittery	Egg clusters.
Old tussock moth, *Notolophus antiqua*	Oct.	18	Apple	South Paris	Larva.
White-marked tussock moth, *Notolophus leucostigma*	March	29	Apple	Kittery	Egg clusters.
White-marked tussock moth, *Notolophus leucostigma*	Aug.	18	Elm	Portland	Cocoons. Shade trees badly infested.
White-marked tussock moth, *Notolophus leucostigma*	April	26	Apple	Orono	Egg clusters.
Well-marked tussock moth, *Notolophus definita*	Aug.	4	Dogwood	Orono	Larvæ nearly grown.
Brown-tail moth, *Euproctis chrysorrhœa*	March	30	Pear	Kittery	Winter nests, common.
Brown-tail moth, *Euproctis chrysorrhœa*	Aug.	22	Pear	Kittery	Young colonies, numerous.
Lesser apple leaf folder, *Teras minuta*	June	3	Apple	Skowhegan	Larvæ.
Fall web worm, *Hyphantria cunea*	Aug.	4	Apple	Albion	Larvæ.
Fall web worm, *Hyphantria cunea*	Aug.	29	Apple	Eliot	Larvæ.
Fall web worm, *Hyphantria cunea*	Sept.	2	Apple	Foxcroft	Larval molts.
—— *Ctenucha virginica*	June	9	Grasses		Cocoon found in apple tree.
—— *Ctenucha virginica*	June	20	Grasses	Farmington	Two cocoons, one was parasited.
—— *Lycomorpha pholus*	Aug.	19	Lichens	Sebago Lake	One moth.
Cut worm, *Feltia subgothica*	Aug.	10		East Sangerville	Moths common.
Chain-streak moth, *Cingilia catenaria*	Sept.	22		Orono	Moths common.
Great tiger moth, *Arctia caia*	July	28		Orono	Moth.
Isabella tiger moth, *Pyrrharctia isabelia*	July	14		Orono	Moth.
Handmaid moth, *Datana ministra*	Aug.	12	Apple	East Bangor	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Aug.	12	Apple	Skowhegan	Larvæ, "many in orchard."
Red-humped caterpillar, *Oedemasia concinna*	Aug.	27	Apple	Dexter	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Aug.	29	Apple	Eliot	Larvæ, all parasited.
Red-humped caterpillar, *Oedemasia concinna*	Aug.	4	Apple	Turner	Larvæ.

Red-humped caterpillar, *Oedemasia concinna*	Aug.	12	Apple	Wiscasset	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Aug.	18	Apple	Sebago Lake	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Aug.	22	Apple	Kittery	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Sept.	2	Apple	Farmington	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Sept.	8	Apple	Skowhegan	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Sept.	9	Apple	South Ampton, L. I	Larvæ.
Red-humped caterpillar, *Oedemasia concinna*	Oct.	3	Apple	Orono	Larvæ and cocoons.
Glassy cut worm, *Hadena devastatrix*	July	20		Foxcroft	Moth.
Cut worms, ——	Aug.	4		Seal Harbor	Larvæ.
Clear-wing moth, *Sesiidae*	July	7	Rose	Hulls Cove	Larvæ.
Achemon sphinx, *Philampelus achemon*	Sept.	5	Apple	Farmington	Larvæ full grown.
Blind-eyed sphinx, *Paonias excœcatus*	Sept.	9	Apple	Houlton	Larvæ full grown.
Mourning-cloak, *Euvanessa antiopa*	July	28	Willow	Portland	Larvæ molts.
——*Grapta faunus*	Aug.	10	Willow	East Sangerville.	Butterfly.
Cottony grass scale, *Eriopeltis festucae*	April	6	Grass	Sedgwick	Egg sacs in meadow, numerous.
Cottony grass scale, *Eriopeltis festucae*	July	20	Grass	Gorham	Egg sacs, common.
Cottony grass scale, *Eriopeltis festucae*	July	28	Grass	Dresden	Egg sacs, ground covered.
Cottony grass scale, *Eriopeltis festucae*	July	28	Grass	Eggemoggin	Egg sacs, thick on stalks.
Cottony grass scale, *Eriopeltis festucae*	Aug.	3	Grass	Orono	Egg sacs, not common.
Cottony grass scale, *Eriopeltis festucae*	Aug.	4	Grass	Portland	Egg sacs, badly infested.
Cottony grass scale, *Eriopeltis festucae*	Aug.	6	Grass	Manchester	Egg sacs, infestation bad.
Plant louse, *Aphis Sp.* (?)	Aug.	29	Rose	Sagadahoc	
Green apple aphis, *Aphis mali*	Jan.	25	Apple		Eggs near leaf-scar on twig.
Green apple aphis, *Aphis mali*	June	26	Apple	Dover	
Green apple aphis, *Aphis mali*	Aug.	29	Apple	South Smithfield	On grafts.
Plant louse aphis, *Aphis Sp*	June	20	High bush cranberry	Seal Harbor	Leaves curled. Syrphus fly larvæ present.
Honey-dew on leaves	June	21		Abbot	"Nearly everything covered for miles."
Potato aphis, *Aphis Sp*	Aug.	12	Potato	Houlton	Common.
Alder blight, *Schizoneura tessellata*	April	26	Alder	Orono	Larval clusters common.
Woolly elm aphis, *Schizoneura americana*	June	11	Elm	Brunswick	In curled leaves which serve as a protection.
Woolly louse of the apple, *Schizoneura lanigera*	July	31	Apple	Gorham	In crevice on tree trunk.
——*Lachnus* (*abietis* probably)	June	10	Fir	Augusta	Giant dark aphids. Wingless form eggs near leaf scars on twigs.
Spruce gall aphis, *Chermes*——?	June	23	Spruce	Orono	Galls common on Norway spruce.
Oyster shell scale, *Mytilaspis pomorum*	Aug.	11	Apple	Portland	Twigs badly incrusted.
Leaf hoppers——?	June	25	Apple	West Falmouth	Larvæ.

INSECTS RECEIVED FOR IDENTIFICATION—CONCLUDED.

Name.	Date.		Host.	Locality.	Remarks.
Tarnished plant bug, *Lygus pratensis*	Sept.	13	Asters	Ellsworth	Larvæ and adults.
Black damsel bug, *Coriscus subcoleoptratus*	July	14		Orono	Larvæ, short winged.
Fleas——				South Freeport	Troublesome in poultry houses.
Hair lice, *Trichodectes*——					Troublesome on horses and cattle.
Croton bugs, *Biatta germanica*				Corinth	"A great pest about the house."
Lace-winged fly, *Chrysopa*	July	20	Aphids	Orono	Eggs on alder leaf.
Syrphus fly, *Syrphus*——	July	7	Aphids	Orono	Larvæ common among *Schizoneura tessellata*.
Robber fly, *Asiladæ*	July	23		Old Town	Caught preying upon cabbage butterfly.
Rat-tailed larva, *Eristalis tenax*	Sept.	28			Two pupal molts from stable floor
Pigeon horn-tail, *Tremex columba*	Aug.	10		Waterville	Female.
Cockoo fly, *hrysididæ*	June	21		Orono	Female.
——*Pelecinus polyturator*	Aug.	10		Orono	Female.
Ichneumon fly, *Thalessa lunata*	July	30		Orono	Female.
Strawberry crown girdler, *Otiorhynchus ovatus*	Aug.	8		Maysville Center	About edge of carpet.
Strawberry crown girdler, *Otiorhynchus ovatus*	Aug.	13		Monson	"House full of them."
Strawberry crown girdler, *Otiorhynchus ovatus*	Aug.	17	Grass roots?	Houlton	Numerous in meadow.
Two-spotted lady beetle, *Adalia bipunctata*	Sept.	17	Aphids	Hallowell	Pupæ and adults on birch leaves.
Lady beetle——	June	28	Aphids	Bar Harbor	Larvæ on rose bush.
Herbivorous lady beetle, *Epilachna borealis*	July	6		Auburn	Cluster of larvæ molting on bark of plum tree.
Larder beetle, *Dermestes lardarius*	May	23		Orono	Adults in woodbox.
Larder beetle, *Dermestes lardarius*	June	20		Rangeley	Great numbers in cottage where rats and mice had been poisoned the fall before.
——*Silvanus surinamensis*	Jan.	7	Corn flour	Orono	700-800 adult beetles in ⅜ quart flour.
Beautiful maple borer, *Plagionotus speciosus*	July	15		Monmouth	Adult.
Carrion beetle, *Silpha americana*	May	13		Orono	
Rove beetle, *Staphylinidæ*	Aug.	1		Dresden	On mushroom.
——*Ips fasciatus*	Aug.	17		Portland	Beetles common in meadow.
Three spotted doryphora, *Doryphora clivicollis*	Aug.	22	Milkweed	Kittery	Larvæ and adults.
Asparagus beetle, *Crioceris asparagi*	June	15	Asparagus	Orono	Adults common in garden.

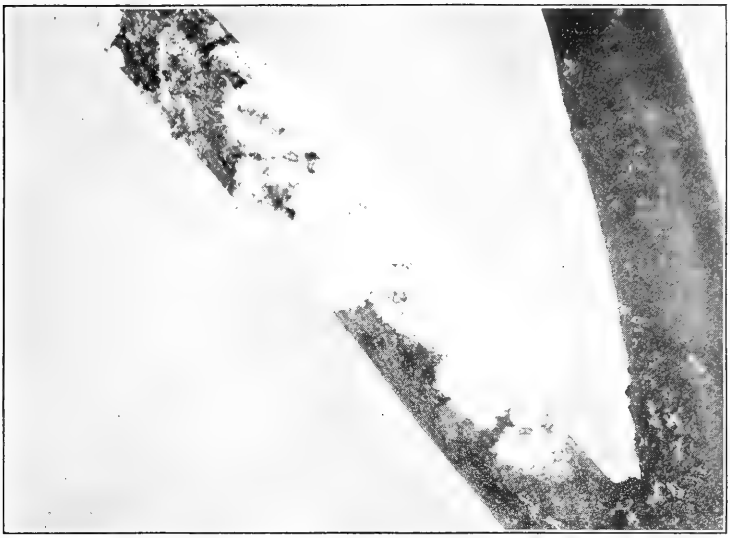

Fig. 33.
Black alder infested with alder blight, *Schizoneura tessellata.*

Fig. 34.
Cone-like gall of aphis common on the Norway and red spruces in eastern Maine.

Fig. 35.

Fig. 36.

Fig. 37.

Fig. 38.

Fig. 39.

Fig. 40.

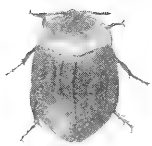

Fig. 41.

Fig. 42.

Fig. 43.

Fig. 44.

Fig. 45

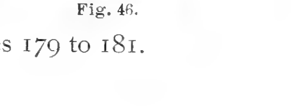

Fig. 46.

Insects referred to on pages 179 to 181.

DIGESTION EXPERIMENTS WITH SHEEP AND STEERS.

J. M. Bartlett.

The experiments here presented were undertaken for the purpose of comparing the digestive capacity of steers with that of sheep. They were begun in the winter of 1901 and completed in 1904, and though the work was carried over a period of nearly four years, not a great many experiments were performed for the reason that only about four months of each year could be devoted to the work, and each experiment required three weeks time.

By far the larger proportion of digestion coefficients obtained in this country are those derived from experiments with sheep, and in calculating rations it has been assumed that these were correct, for all ruminants at least. The small size of sheep and the ease with which they can be handled, probably accounts for their more general use, but our experience with them leads us to believe that, as a rule, they are much less desirable for this purpose than steers. They are nervous, restless and more liable to lose their appetite when confined in stalls, and parallel experiments with two or more animals are subject to wider variations. Out of a dozen different sheep the writed has used, only one really satisfactory animal, equal to the steer, has been found.

DESCRIPTION OF ANIMALS.

The steers used were grade Durhams which were bought in the country and had been rather poorly fed before they came to the Station. They were, therefore, small of their age, weighing about 300 lbs. at one and one-half years old, when the experiments were begun. Although small, they were hearty and rugged, ate their rations well and did not appear to mind the confinement.

The sheep employed for the first two seasons were young Shropshires that were not very satisfactory. They were small eaters, especially of coarse fodders, and had to be handled very carefully to prevent them from getting out of condition. The third season large well matured lambs were obtained, but they did not take kindly to the confinement, probably because they were so young, and all comparative experiments with them had to be abandoned. The fourth season they were again tried and were more satisfactory.

METHOD.

The method of experiment employed with the sheep was practically the same as has been previously used at this Station, and described in Report for 1891, p. 25, except that the platform on which the sheep stood was raised so that the urine could be collected. For this purpose a rubber funnel was attached with straps passing over the animal's back, and a rubber tube led from it to convey the urine to a vessel beneath the platform. The whole experiment covered a period of twelve or thirteen days, the first seven days being a preliminary feeding period, while during the last five or six days the feces and urine were all collected, weighed and sampled for analysis.

The first two seasons the steers were so small that rubber lined pouches for collecting the feces, similar to those used on sheep, worked very satisfactorily. But during the third summer they made very rapid growth and attained such size that the pouch was no longer practicable and a galvanized iron trough was set in the rear of the platform so that it would secure all the droppings, and a strong wire running across behind the steer prevented him from stepping back into it. The stall and platform were just long enough to accommodate the animal, and all feces fell into the galvanized iron trough. Each ration of hay and grain were carefully weighed, the feces were collected in iron tubs and weighed at the end of the period on the same scales used to weigh the ration. The work was only carried on during cold weather, so no fermentation took place. The urine from the steers was collected with rubber funnels the same as with sheep. Between the experiments the animals were given a week's rest, which was necessary to keep them in good condition.

EXPLANATION OF TABLES.

The tables given on pages 188-189 contain the figures representing the chemical composition, or percentages of nutrients in the foods used in each experiment; also the composition of the feces for each sheep, and the heat of combustion for the foods and feces. The percentages given are on the same moisture bases as the figures given in the tables which follow. The tables on pages 190-191 contain the same data as the above relating to the steers.

The table on page 192 gives the total amount of food consumed by each sheep for each experiment and the feces excreted, also the time covered by the experiments.

The table on page 193 contains the percentage of each nutrient digested or the digestive coefficients for each sheep.

The table on page 194 gives the amount of food consumed by each steer and the feces excreted for each experiment.

The table on page 195 gives the digestion coefficients obtained for each steer.

In the tables on pages 196-197 are given a summary of the coefficients obtained in the experiments described in this bulletin. In the Station reports for 1897 and 1900 will be found summary tables giving all digestion coefficients which have been obtained at this Station previously.

The tables given on page 198 contain the average coefficients obtained for both sheep and steers on the different feed stuffs and mixtures, used in the experiments made to compare their digestive capacities.

The table on page 199 contains the coefficients obtained with the steers alone on mixtures of hay, corn meal and gluten meal.

The description of each experiment follows the tables on pages 199 and following:

COMPOSITION OF FOODS AND FECES IN DIGESTION EXPERIMENTS WITH SHEEP.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per gram.
Experiment 86.		%	%	%	%	%	%	%	Cal.
Clover silage	4259	21.14	19.20	1.94	2.25	8.25	7.97	0.73	1.073
Feces, Sheep I	4260	91.24	81.57	9.67	10.56	33.76	33.95	3.30	4.223
Feces, Sheep II	4261	91.25	81.76	9.49	11.94	33.09	33.51	3.22	4.201
Feces, Sheep III	4262	90.83	81.30	9.53	10.13	31.82	36.46	2.89	4.205
Experiment 87.									
Clover hay	4263	81.46	75.63	5.83	7.90	27.63	38.34	1.76	3.635
Feces, Sheep I	4264	91.45	83.14	8.31	8.56	35.44	36.79	2.35	4.294
Feces, Sheep II	4265	91.86	82.78	9.08	8.56	35.06	36.69	2.47	4.177
Feces, Sheep III	4266	91.79	83.79	8.00	8.75	34.76	37.92	2.36	4.179
Experiment 88.									
Timothy hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.618
Feces, Sheep I	4275	91.90	85.16	6.74	7.63	30.01	43.75	3.77	4.379
Feces, Sheep III	4277	91.64	85.08	6.56	6.94	30.59	44.33	3.22	4.343
Experiment 89.									
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.618
Coarse spring wheat bran	4309	92.57	86.01	6.56	16.63	11.17	53.11	5.00	4.118
Feces, Sheep I	4268	92.02	83.20	8.82	8.69	25.83	43.52	5.16	4.374
Feces, Sheep II	4269	90.83	81.75	9.08	8.94	24.49	43.60	4.72	4.227
Feces, Sheep III	4270	91.61	83.39	8.22	8.31	25.73	44.18	5.17	4.356
Experiment 90.									
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.614
Winter wheat mixed feed	4310	90.70	84.60	6.10	16.13	13.33	49.94	5.20	4.044
Feces, Sheep II	4272	91.77	83.24	8.53	9.13	26.80	43.71	3.60	4.333
Feces, Sheep III	4273	92.16	83.78	8.50	8.50	26.85	45.44	2.99	4.223
Experiment 91.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	3.691
Cottonseed meal	4211	91.99	84.40	7.59	46.75	6.23	21.64	9.78	4.662
Feces, Sheep II	4288	91.02	83.26	7.76	9.31	28.69	41.93	3.33	4.262
Feces, Sheep III	4289	91.02	84.01	7.01	9.06	27.99	43.68	3.28	4.310
Experiment 92.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	3.691
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	4.662
Feces, Sheep II	4291	90.45	81.91	8.54	10.50	28.53	39.89	2.99	4.200
Feces, Sheep III	4292	90.58	82.11	8.74	10.81	27.67	40.60	3.09	4.236
Experiment 93.									
Hay	4306	83.90	79.66	4.24	5.00	26.98	44.26	3.42	3.810
Coarse corn meal	4307	87.54	86.62	1.02	9.06	2.25	72.25	2.96	3.881
Feces, Sheep II	4293	89.69	83.17	6.52	9.75	27.92	41.91	3.59	4.279
Feces, Sheep III	4295	90.52	84.49	6.03	8.81	30.26	42.44	2.98	4.268
Experiment 94.									
Hay	4306	83.90	79.66	4.24	5.00	26.98	44.26	3.42	3.810
Fine corn meal	4308	87.53	86.51	1.02	8.81	2.09	72.28	3.33	3.903
Feces, sheep II	4297	89.32	83.17	6.15	8.56	28.29	43.25	3.07	4.236
Experiment 102.									
Corn fodder	4313	51.38	48.06	3.32	4.24	15.61	27.28	0.93	2.260
Waste, Sheep I	4324	46.13	40.43	5.70	3.99	13.22	22.45	0.77	
Waste, Sheep II	4325	43.71	40.93	2.78	3.14	14.25	23.04	0.50	
Feces, Sheep I	4327	88.63	75.90	12.73	11.13	20.75	42.07	1.95	3.964
Feces, Sheep II	4328	89.74	77.83	11.91	10.75	23.77	41.76	1.55	4.004
Experiment 103.									
Leaming corn silage	4315	19.60	18.60	1.00	1.60	5.42	11.09	.49	.916
Feces, Sheep I	4329	89.58	81.70	7.88	9.44	25.09	45.81	1.36	4.076
Feces, Sheep II	4330	89.43	81.81	7.62	8.81	27.57	44.01	1.42	4.053

COMPOSITION OF FOODS AND FECES, SHEEP—CONCLUDED.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per gram.
Experiment 104.		%	%	%	%	%	%	%	Cal.
Timothy hay	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	3.791
Feces, Sheep I	4333	90.00	83.23	6.77	7.75	31.41	41.72	2.35	4.262
Feces, Sheep II	4334	89.44	82.08	7.36	7.63	29.79	42.13	2.53	4.231
Experiment 105.									
Hay	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	3.791
Linseed meal	4359	89.44	83.71	5.73	40.81	7.36	33.53	1.51	4.097
Feces, Sheep II	4336	89.81	81.22	8.59	11.63	29.44	37.52	2.63	4.193
Experiment 106.									
Hay	4320	82.24	94.71	5.29	6.77	33.10	52.51	2.33	
Corn meal	4360	81.16	98.39	1.61	13.01	2.56	79.97	2.85	
Feces, Sheep I	4337	89.50	80.28	9.22	12.44	27.14	38.39	2.31	
Experiment 118.									
Soy-bean—corn silage	4408	20.20	19.03	1.17	2.13	5.11	9.62	2.17	8.722
Feces, Sheep I	4392	91.92	81.88	10.04	10.69	29.72	37.98	3.49	4.168
Feces, Sheep II	4393	91.55	79.79	11.76	14.25	26.65	35.74	3.15	4.107
Experiment 119.									
Hay	4405	81.54	77.08	4.46	6.60	24.50	43.20	2.82	3.712
Feces, Sheep I	4388	91.09	83.19	7.90	8.44	28.60	42.12	2.68	4.201
Feces, Sheep II	4389	90.93	82.40	8.53	10.00	29.70	38.45	2.65	4.177
Experiment 120.									
Hay	4410	82.49	77.96	4.53	7.47	25.76	42.08	2.65	3.790
Linseed meal	4419	91.71	86.49	5.22	31.13	9.43	32.36	8.59	4.523
Corn meal	4418	88.55	87.27	1.28	8.44	1.99	72.95	2.54	3.891
Feces, Sheep I	4390	92.37	22.94	9.43	11.69	27.85	38.36	3.17	4.261
Feces, Sheep II	4391	92.94	83.79	9.15	11.75	27.30	39.45	3.41	4.285
Experiment 121.									
Hay	4411	85.36	81.23	4.13	7.04	25.19	46.20	2.80	4.000
Middlings	4420	90.92	86.93	3.99	18.13	5.22	55.97	4.71	4.165
Feces, Sheep I	4394	91.06	82.20	8.86	9.31	28.43	40.32	2.65	4.139
Feces, Sheep II	4395	91.86	82.56	9.30	9.31	29.15	39.82	2.79	4.222
Experiment 122.									
Hay	4414	86.05	81.68	4.37	6.49	26.63	45.98	2.58	3.945
Low grade cottonseed meal	4425	90.48	85.78	4.70	23.81	21.43	30.53	6.20	4.389
Feces, Sheep I	4396	90.82	82.89	7.93	11.00	31.73	36.40	2.00	4.185
Feces, Sheep II	4397	92.02	84.41	7.61	11.38	31.60	37.54	2.07	
Experiment 123.									
Hay	4416	89.20	84.53	4.67	7.37	27.53	46.41	3.22	4.013
Medium grade cottonseed meal	4424	88.40	81.90	6.50	34.13	13.58	19.83	8.90	3.854
Feces, Sheep I	4400	91.54	81.66	9.88	12.44	29.73	34.96	2.54	4.172
Feces, Sheep II	4401	91.94	81.60	10.34	11.88	31.20	34.59	2.03	4.150
Experiment 124.									
Hay	4415	87.34	83.09	4.25	6.66	27.36	46.31	2.76	4.007
Cottonseed meal(dark col'r'd)	4423	87.28	80.23	7.05	42.50	7.67	14.64	8.62	3.785
Feces, Sheep I	4398	91.21	80.85	10.36	14.00	27.03	35.14	2.44	4.184
Feces, Sheep II	4399	90.79	80.49	10.30	15.00	27.77	33.06	2.26	4.152

COMPOSITION OF FOODS AND FECES IN DIGESTION EXPERIMENTS WITH STEERS.

	Station number,	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per pound.
Experiment 95.		%	%	%	%	%	%	%	
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	1,641
Feces, Steer I	4279	91.11	84.60	6.51	8.38	28.54	44.35	3.33	1,993
Feces, Steer II	4280	92.14	85.56	6.58	7.81	28.04	46.25	3.46	1,993
Experiment 96.									
Hay, 4,274.									
Spring wheat bran	4309	92.57	86.01	6.56	16.63	11.17	53.21	5.00	1,868
Feces, Steer I	4283	90.94	81.25	8.69	9.19	26.78	43.13	3.15	1,930
Feces, Steer II	4284	90.72	81.76	8.96	9.44	27.06	41.63	3.63	1,934
Experiment 97.									
Hay, 4,274.									
Winter wheat mixed feed	4310	90.70	84.60	6.10	16.13	13.33	49.94	5.20	1,834
Feces, Steer I	4281	91.61	83.34	8.27	9.06	26.45	44.86	2.97	1,913
Feces, Steer II	4282	91.06	82.72	8.24	9.25	27.22	42.89	3.46	1,923
Experiment 98.									
Hay	4304	88.26	84.01	4.25	5.42	28.45	46.83	3.31	1,788
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	2,115
Feces, Steer I	4285	91.43	83.66	7.77	10.69	28.47	41.57	2.93	1,947
Feces, Steer II	4286	90.49	82.39	8.10	10.38	27.98	40.95	3.08	1,947
Experiment 99.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	1,674
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	2,115
Feces, Steer I	4298	91.28	83.11	8.17	11.25	27.49	41.29	3.08	1,942
Feces, Steer II	4299	90.53	82.51	8.02	11.31	27.05	40.87	3.28	1,934
Experiment 100.									
Hay	4306	83.90	79.66	4.24	5.00	26.08	44.26	3.42	1,728
Coarse corn meal	4307	87.54	86.52	1.02	9.06	2.25	72.25	2.96	1,760
Feces, Steer I	4300	90.24	83.82	6.42	9.19	29.23	42.16	3.24	1,952
Feces, Steer II	4301	91.54	84.66	6.88	9.44	27.17	44.57	3.48	1,970
Experiment 101.									
Hay, 4,306.									
Fine corn meal	4308	87.53	86.51	1.02	8.81	2.09	72.28	3.33	1,770
Feces, Steer I	4302	89.71	83.48	6.23	9.38	28.85	42.05	3.20	1,940
Feces, Steer II	4303	91.50	85.02	6.48	9.44	28.03	44.62	2.93	1,977
Experiment 107.									
Corn fodder	4313	51.38	48.06	3.32	4.24	15.61	27.28	.93	1,025
Feces, Steer I	4341	89.23	77.80	11.43	11.75	20.01	44.44	1.60	1,847
Feces, Steer II	4342	89.29	78.92	10.37	11.63	20.41	45.15	1.73	1,859
Experiment 108.									
Sanford corn silage	4314	20.19	19.14	1.05	1.41	5.27	12.01	0.45	415
Feces, Steer I	4343	89.27	79.60	9.67	11.13	20.99	45.58	1.90	1,863
Feces, Steer II	4344	89.20	79.11	10.09	11.88	21.06	44.25	1.92	1,851
Experiment 109.									
Leaming corn silage	4315	19.60	18.60	1.00	1.60	5.42	11.09	0.49	415
Feces, Steer I	4345	89.96	82.18	7.78	9.69	23.10	47.91	1.48	1,877
Feces, Steer II	4346	89.33	79.89	9.44	11.13	20.07	47.11	1.58	1,850
Experiment 110.									
Feed flour	4358	82.14	79.18	2.96	21.38	2.25	54.83	0.72	1,702
Feces, Steer I	4347	89.94	79.59	10.35	12.81	21.49	43.12	2.17	1,873
Feces, Steer II	4348	89.54	79.10	10.44	12.38	22.26	42.56	1.90	1,845
Experiment 111.									
Hay, mostly timothy	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	1,719
Feces, Steer I	4351	89.95	82.71	7.24	9.06	28.37	42.30	2.98	1,956
Feces, Steer II	4352	89.08	81.89	7.19	8.56	28.24	42.23	2.86	1,944

COMPOSITION OF FODDERS AND FECES, STEERS—CONCLUDED.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per pound, air dry or fresh.
Experiment 112.		%	%	%	%	%	%	%	
Linseed meal	4359	89.44	83.71	5.73	40.81	7.86	33.53	1.51	1,958
Feces, Steer I	4353	89.70	81.31	8.39	10.81	27.37	40.45	2.68	1,906
Experiment 113.									
Hay	4321	87.11	82.49	4.62	5.24	29.63	45.77	1.85	
Linseed meal	4359								
Corn meal	4360	81.16	79.85	1.31	10.56	2.08	64.90	2.30	
Feces, Steer II	4355	90.26	82.17	8.09	11.13	27.92	40.44	2.68	
Experiment 114.									
Hay	4362	84.46	79.53	4.93	5.94	27.25	44.02	2.32	1,709
Feces, Steer I	4363	19.04	17.33	1.71	1.66	6.87	8.11	.69	402
Feces, Steer II	4364	20.36	18.47	1.89	1.85	7.11	8.77	.74	433
Experiment 115.									
Hay	4365	83.00	77.59	5.41	6.28	26.15	42.81	2.35	1,692
Corn meal	4375	88.94	78.63	1.31	9.74	1.58	72.51	3.80	1,775
Feces, Steer I	4366	18.25	16.63	1.62	2.52	5.23	8.09	.79	393
Feces, Steer II	4367	18.39	16.61	1.78	2.51	5.33	7.99	.78	400
Experiment 116.									
Hay	4368	85.28	79.42	5.86	7.17	28.78	41.31	2.16	1,747
Gluten feed	4376	90.61	89.57	1.04	26.38	8.48	50.72	3.99	399
Feces, Steer I	4369	17.81	16.13	1.68	2.56	4.72	8.14	0.71	402
Feces, Steer II	4370	18.41	16.58	1.83	2.68	4.80	8.34	0.76	399
Experiment 117.									
Hay	4368	85.10	79.52	5.58	7.72	26.40	42.83	2.57	1,747
Gluten feed	4376								
Feces, Steer I	4372	16.48	14.85	1.63	2.24	4.94	7.13	0.54	403
Feces, Steer II	4373	18.75	16.62	2.13	2.51	5.53	7.98	0.60	399
Experiment 125.									
Soy-bean—corn silage	4406	18.92	17.87	1.05	1.90	5.06	......	......	370
Feces, Steer II	4382	14.55	1.82	1.82	2.13	4.95	5.14	.51	302
Experiment 126.									
Hay	4404	82.74	78.37	4.37	7.45	25.17	42.83	2.92	1,661
Soy-bean—corn silage	4407	20.94	19.61	1.33	1.98	5.42	11.55	0.66	408
Feces, Steer I	4383	17.53	16.70	1.83	2.08	5.92	7.27	.43	348
Feces, Steer II	4384	15.88	14.30	1.58	1.84	5.45	6.63	.38	324
Experiment 127.									
Hay	4404	82.74	78.37	4.37	7.45	25.17	42.83	2.92	1,661
Feces, Steer I	4377	20.35	18.56	1.79	2.14	6.04	9.38	1.01	438
Feces, Steer II	4378	22.33	20.33	2.00	2.47	6.58	10.19	1.09	479
Experiment 128.									
Hay	4409	91.29	86.59	4.70	7.81	27.62	46.62	3.29	1,661
Corn meal	4418	88.55	87.27	1.28	8.44	1.99	72.95	2.54	1,765
Linseed meal	4419	91.71	86.49	5.22	31.13	9.43	32.36	8.59	2,051
Feces, Steer I	4379	20.14	18.18	1.96	2.62	5.94	8.98	0.74	428
Feces, Steer II	4380	21.33	19.35	1.98	2.50	6.51	9.59	0.75	454
Experiment 129.									
Hay	4412	87.50	83.07	4.43	6.34	26.65	47.13	2.95	1,817
Spring wheat middlings	4421	86.52	83.50	3.02	13.31	4.18	60.96	2.92	1,680
Feces, Steer II	4387	21.06	18.45	2.61	2.56	6.40	8.84	0.65	459

DATA RELATIVE TO DIGESTION EXPERIMENTS WITH SHEEP.

Number of experiment.	Animal's number.	Length of experiment in days.	The food consumed by each animal during the experiment.	Total feces—grams.
86	I..	5	Clover silage, 15,000 grams	1,970
86	II..	5	Clover silage, 10,000 grams	1,463
86	III..	5	Clover silage, 12,500 grams	1,875
87	I..	5	Clover hay, 5,000 grams	2,133
87	II..	5	Clover hay, 4,000 grams	1,731
87	III..	5	Clover hay, 4,000 grams	1,775
88	I..	5	Timothy hay, 4,859 grams	2,165
88	III..	5	Timothy hay, 3,936 grams	1,825
89	I..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,813
89	II..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,828
	III..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,833
90	II..	5	Hay, 3,000 grams, winter wheat mixed feed, 1,500 gr...	1,678
90	III..	5	Hay, 3,000 grams, winter wheat mixed feed, 1,500 gr...	1,768
91	II..	5	Hay, 4,000 grams, cottonseed meal, 500 grams	1,866
91	III..	5	Hay, 4,000 grams, cottonseed meal, 500 grams	1,909
92	II..	5	Hay, 4,000 grams, cottonseed meal, 1,000 grams	1,971
92	III..	5	Hay, 4,000 grams, cottonsesd meal, 1,000 grams	1,946
93	I..	5	Hay, 3,000 grams, coarse corn meal, 1,000 grams	1,522
93	III..	5	Hay, 3,000 grams, coarse corn meal, 1,000 grams	1,697
94	II..	5	Hay, 3,000 grams, fine corn meal, 1,000 grams	1,547
102	I..	6	Corn fodder, 4,200 grams, 483 grams waste	754
102	II..	6	Corn fodder, 4,200 grams, 313 grams waste	843
103	I..	6	Leaming corn silage, 15,000 grams	1,243
103	II..	6	Leaming corn silage, 15,000 grams	1,354
104	I..	5	Timothy hay, 3,500 grams	1,346
104	II..	5	Timothy hay, 3,500 grams	1,345
105	III..	5	Hay, 3,500 grams, linseed meal, 1,500 grams	1,406
106	I..	5	Hay, 2,500 grams, linseed meal, 1,000 grams, corn meal, 1,000 grams	1,137
118	I..	6	Soy bean--corn silage, 18,000 grams	1,182
118	II..	6	Soy bean—corn silage, 12,000 grams	727
119	I..	6	Hay, 6,000 grams	2,717
119	II..	6	Hay, 4,800 grams	2,191
120	I..	6	Hay, 3,600 gr., linseed meal, 900 gr., corn meal, 900 gr...	1,905
120	II..	6	Hay, 3,600 gr., linseed meal, 900 gr., corn meal, 900 gr...	1,881
121	I..	6	Hay, 4,800 grams, middlings, 2,400 grams	2,726
121	II..	6	Hay, 2,400 grams, middlings, 1,200 grams	1,392
122	I..	6	Hay, 6,000 grams, low grade cottonseed meal, 3,000 gms.	4,075
122	II..	6	Hay, 3,600 grams, low grade cottonseed meal, 1,800 gms.	2,311
123	I..	6	Hay, 6,000 gr., medium grade cottonseed meal, 3,000 gr.	3,833
123	II..	6	Hay, 4,800 gr., medium grade cottonseed meal, 2,400 gr.	2,843
124	I..	6	Hay, 6,000 grams, cottonseed meal (off color) 3,000 gms.	3,471
124	II..	6	Hay, 6,000 grams, cottonseed meal (off color) 2,400 gms.	2,545

COEFFICIENTS OBTAINED IN DIGESTION EXPERIMENTS WITH SHEEP.

Material.	Number of experiment.	Animal's number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Clover silage.	86	I	43.3	44.2	34.5	38.3	46.3	44.1	40.6	47.7
	86	II	36.8	37.7	28.5	22.4	41.3	38.5	35.5	40.8
	86	III	31.7	36.4	26.3	32.3	42.1	31.2	40.4	39.7
Clover hay.	87	I	52.1	53.1	39.2	53.8	42.4	59.1	43.4	51.0
	87	II	48.8	52.6	32.6	53.1	45.2	58.6	40.7	49.3
	87	III	50.2	51.0	39.3	51.0	44.4	56.3	41.0	48.1
Timothy hay.	88	I	49.1	50.1	31.0	31.5	45.7	58.0	23.3	47.2
	88	II	47.1	48.0	30.3	35.0	43.9	53.5	31.3	44.2
Coarse spring wheat bran..	89	I	69.6	66.6	30.4	76.4	63.1	74.2	37.7	
	89	II	70.1	73.7	24.2	74.1	75.6	73.2	47.6	
	89	III	69.5	72.8	31.5	76.3	66.7	73.0	40.5	64.0
Winter wheat bran (mixed feed).	90	II	78.4	80.9	43.4	77.4	78.5			
	90	III	71.9	74.6	35.5	78.6	66.0	......	......	71.8
Hay and cottonseed meal 8 to 1.	91	II	54.8	56.4	26.5	59.4	49.6	59.4	56.2	52.3
	91	III	53.8	55.0	32.0	59.6	49.7	56.8	55.9	50.6
Hay and cottonseed meal 8 to 2.	92	II	57.7	59.2	28.3	68.7	48.5	61.4	69.2	55.4
	92	III	58.2	59.9	29.8	68.2	50.7	61.2	69.2	50.9
Coarse corn meal.	93	I	93.2	94.0	......	46.5	......	79.1	......	78.3
	93	III	73.7	74.9	......	45.4	......	81.5		
Fine corn meal.	94	II	89.2	90.2	31.3	63.2	56.4	88.6	......	88.0
Cut corn fodder.	102	I	65.5	68.7	14.2	47.2	72.6	69.4	52.6	
	102	II	62.5	65.3	23.0	46.2	67.2	67.0	66.0	
Leaming corn silage.	103	I	61.2	63.5	34.7	51.2	61.6	65.8	77.0	46.4
	103	II	58.8	60.3	31.8	50.5	54.0	64.2	73.9	42.7
Timothy hay, some clover.	104	I	59.1	60.0	43.0	43.9	56.2	64.3	57.9	56.2
	104	II	59.7	65.7	38.5	45.2	58.8	63.6	55.0	56.5
Linseed meal.	105	II	95.5	88.6	69.6	90.1	......	......	81.4	88.4
Linseed meal and corn meal (mixed equal parts).	106	I	89.2	91.2	42.6	87.5	80.4	95.1	85.9	
	106	II	82.4	93.9	......	78.3	......	......	89.0	......
Soy bean—corn silage.	118	I	70.1	71.8	45.6	67.0	61.8	74.1	89.4	67.2
	118	II	72.6	74.6	39.1	68.2	68.4	79.4	91.2	71.2
Hay, largely timothy.	119	I	49.4	51.1	19.7	42.1	47.2	55.9	57.0	48.1
	119	II	49.3	51.2	16.2	36.5	45.9	57.7	57.1	48.5
Linseed and corn meal (equal parts).	120	I	83.3	86.4	......	85.4	71.2	90.5	80.5	81.0
	120	II	84.1	86.7	......	85.9	88.4	89.4	76.8	81.7
Spring wheat middlings.	121	I	81.5	83.8	......	91.0	......	87.8	87.0	82.3
	121	II	78.1	81.1	......	90.6	......	87.5	84.5	76.8
Low grade cottonseed meal	122	I	60.1	61.5	......	71.9	30.3	65.7	87.3	58.7
	122	II	62.8	66.6	......	73.3	45.2	69.5	92.8	
Medium grade cottonseed meal.	123	I	66.8	73.3	......	80.9	39.8	72.8	94.6	61.6
	123	II	79.2	82.7	......	86.2	47.2	91.3	......	71.8
Dark cottonseed meal.	124	I	80.6	84.5	......	81.8	......	89.7	94.7	72.1
	124	II	91.0	95.2	......	82.5	......	99.6	99.7	83.4

DATA RELATIVE TO DIGESTION EXPERIMENTS WITH STEERS.

Number of experiment.	Animal's number.	Length of experiment in days.	The food consumed by each animal during each experiment.	Total feces air dry or fresh—pounds.
95	I....	5	Timothy hay, 40 pounds	15.8
95	II....	5	Timothy hay, 40 pounds	15.7
96	I....	5	Hay, 35 pounds, coarse spring wheat bran, 15 pounds.	19.4
96	II....	5	Hay, 35 pounds, coarse spring wheat bran, 15 pounds.	18.7
97	I....	5	Hay, 35 pounds, winter wheat bran, 15 pounds	18.2
97	II....	5	Hay, 35 pounds, winter wheat bran, 15 pounds	18.2
98	I....	5	Hay, 40 pounds, cottonseed meal, 5 pounds	18.5
98	II....	5	Hay, 40 pounds, cottonseed meal, 5 pounds	18.7
99	I....	5	Hay, 40 pounds, cottonseed meal, 10 pounds	18.7
99	II....	5	Hay, 40 pounds, cottonseed meal, 10 pounds	18.8
100	I....	5	Hay, 50 pounds, coarse corn meal, 10 pounds	23.0
100	II....	5	Hay, 40 pounds, coarse corn meal, 10 pounds	21.7
101	I....	5	Hay, 50 pounds, fine corn meal, 10 pounds	22.1
101	II....	5	Hay, 40 pounds, fine corn meal, 10 pounds	18.0
107	I....	5	Corn fodder, 70 pounds	10.8
107	II....	5	Corn fodder, 70 pounds	11.1
108	I....	5	Sanford corn silage, 200 pounds	11.7
108	II....	5	Sanford corn silage, 200 pounds	11.1
109	I....	5	Leaming corn silage, 150 pounds	13.0
109	II....	5	Leaming corn silage, 150 pounds	11.7
110	I....	5	Leaming corn silage, 150 pounds, feed flour, 20 lbs....	14.8
110	II....	5	Leaming corn silage, 150 pounds, feed flour, 20 lbs....	14.2
111	I....	5	Hay, 50 pounds	19.6
111	II....	5	Hay, 50 pounds	19.8
112	I....	5	Hay, 50 pounds, linseed meal, 10 pounds	21.3
113	II....	5	Hay, 50 lbs., linseed meal, 10 lbs., corn meal, 10 lbs....	21.7
114	I....	5	Hay, 80 pounds	148.0
114	II.. .	5	Hay, 80 pounds	135.3
115	I....	5	Hay, 50 pounds, 30 pounds corn meal	115.8
115	II....	5	Hay. 50 pounds, 30 pounds corn meal	116.0
116	I....	5	Hay, 50 pounds, 30 pounds gluten feed	116.5
116	II....	5	Hay, 50 pounds, 30 pounds gluten feed	108.0
117	I....	5	Hay, 50 pounds, 15 pounds gluten feed	113.5
117	II....	5	Hay, 50 pounds, 15 pounds gluten feed	100.5
125	II....	6	Soy bean—corn silage, 325 pounds	127.0
126	I....	6	Hay, 30 pounds, soy bean—corn silage, 240 pounds	144.0
	II....	6	Hay, 60 pounds, soy bean—corn silage, 240 pounds	237.0
127	I....	6	Hay, 108 pounds	180 5
	II....	6	Hay, 108 pounds	190.3
128	I....	6	Hay, 72 lbs., corn meal, 18 lbs., linseed meal, 18 lbs....	155.5
	II....	6	Hay, 72 lbs., corn meal, 18 lbs., linseed meal, 18 lbs....	160.5
129	II....	6	Hay, 72 pounds, middlings, 36 pounds	157.5

COEFFICIENTS OBTAINED IN DIGESTION EXPERIMENTS WITH STEERS.

Material Fed.	Number of experiment.	Animal's number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Hay, largely Timothy.	95	I	55.1	55.9	41.5	33.0	54.3	60.2	36.3	51.6
	95	II	54.78	55.5	41.5	37.6	55.3	58.6	35.2	51.7
Spring wheat bran (coarse)	96	I	64.2	68.9	20.4	73.5	21.8	73.5	82.7	
	96	II	68.67	72.4	20.4	73.9	29.9	80.1	73.4	63.6
Winter wheat bran (mixed feed).	97	I	70.4	73.0	33.7	76.5	53.5	74.4	92.3	
	97	II	71.1	73.0	34.8	76.9	47.0	78.5	80.8	70.0
Hay and cottonseed meal 8 to 1.	98	I	57.5	59.1	69.9	56.1	54.9	61.1	70.1	54.9
	98	II	57.5	59.2	72.3	56.9	55.2	61.3	68.5	54.4
Hay and cottonseed meal 8 to 2.	99	I	59.5	61.0	35.3	68.1	52.8	62.0	69.7	56.6
	99	II	59.6	61.0	35.7	67.8	53.4	62.2	67.1	56.6
Coarse corn meal.	100	I	78.4	81.2	......	46.2	......	90.1		
	100	II	88.7	91.9	......	53.9	.....	90.5	......	80.0
Fine corn meal.	101	I	88.4	90.3	......	47.7	......	94.8		
	101	II	86.7	88.5	......	50.6	......	91.3	......	90.0
Cut corn fodder.	107	I	73.2	75.0	47.0	57.2	80.2	74.9	73.8	71.2
	107	II	72.6	74.1	50.4	56.6	79.3	73.9	70.8	70.4
Sanford corn silage.	108	I	74.0	75.5	47.7	53.9	76.6	77.8	76.3	73.2
	108	II	75.7	77.3	47.1	53.5	77.9	79.7	77.7	74.7
Leaming corn silage.	109	I	60.4	61.9	32.7	47.5	63.3	62.2	60.8	60.2
	109	II	65.8	67.7	30.7	45.9	71.1	65.9	75.7	64.5
Feed flour.	110	I	66.8	70.1	......	78.2	......	77.7	......	73.9
	110	II	67.1	70.3	......	80.0	......	73.3		
Hay, Timothy with some clover.	111	I	58.4	59.6	37.9	34.2	59.8	63.2	46.3	55.1
	111	II	58.2	59.8	37.9	36.4	59.4	62.7	47.2	54.9
Linseed meal.	112	I	84.1	87.2	36.8	85.7	69.6	91.4	......	81.3
Linseed meal and corn meal.	113	II	91.5	92.5	52.8	86.2	93.0	96.8	81.3	
Hay, largely Timothy.	114	I	58.3	59.7	35.8	48.2	53.4	65.9	45.2	57.5
	114	II	59.2	60.7	35.0	47.4	55.9	66.3	45.7	56.9
Mixture—Hay 10 lbs. and corn meal 6 lbs.	115	I	69.0	70.4	39.5	51.9	66.2	78.3	60.8	66.1
	115	II	68.7	70.4	33.4	51.9	65.3	78.5	61.2	64.0
Mixture—Hay 10 lbs. and gluten feed 6 lbs.	116	I	70.3	71.8	38.3	74.1	67.5	73.6	63.7	66.5
	116	II	71.5	73.1	38.9	74.8	69.4	74.9	63.9	68.5
Gluten feed—Hay 10 lbs., gluten feed 3 lbs.	117	I	91.3	92.3	......	85.4	......	89.1		
	117	II	90.4	93.4	......	86.0	......	90.0	......	86.3
Soy bean—corn silage.	125	II	70.5	72.2	31.3	56.4	61.7	80.5	66.7	67.7
Soy bean—corn silage, fed with hay.	126	I	69.0	70.5	43.6	53.5	50.8	79.7	......	71.7
	126	II	61.7	71.6	48.0	61.9	59.6	80.4	88.3	68.5
Hay, largely Timothy.	127	I	58.9	60.4	31.6	39.6	59.9	63.4	42.3	55.3
	127	II	52.5	54.3	19.5	41.7	54.0	58.2	34.2	48.6
Corn and linseed meal. (Equal parts.)	128	I	93.43	94.5	54.7	84.8	67.5	95.8	......	81.2
	128	II	84.44	85.6	43.4	85.7	87.4	88.2	......	76.2
Middlings.	129	II	83.4	88.3	......	72.7	......	98.6	......	82.9

SUMMARY OF DIGESTION COEFFICIENTS WITH SHEEP.

Material.	Number of experiment.	Number of animals.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Clover silage	86	3	37.3	39.4	29.8	31.0	43.2	37.9	38.8	42.7
Clover hay	87	3	50.4	52.2	37.0	52.6	43.9	58.0	41.7	49.4
Timothy hay (late cut)	88	2	48.1	49.1	30.7	33.3	44.8	55.8	27.3	46.0
Mixed hay (some clover)	104	2	59.4	60.5	40.8	44.6	57.5	64.0	56.5	58.4
Hay largely timothy	119	2	49.3	51.2	16.2	36.5	45.9	57.7	57.1	48.5
Corn fodder (few ears glazed)	102	2	64.0	67.0	18.6	46.7	69.9	68.2	59.3	
Corn silage (immature corn)	103	2	60.0	61.9	33.3	50.9	57.8	65.0	75.5	44.6
Soy bean—corn silage	118	2	71.4	73.2	42.7	62.6	65.1	76.8	90.3	69.2
Coarse spring wheat bran	89	3	69.5	72.8	31.5	76.3	66.7	73.0	40.5	64.0
Winter wheat, mixed feed	90	2	72.5	77.6	39.5	78.0	72.3	......	......	71.8
Coarse corn meal	93	2	83.5	84.6	......	46.0	......	80.3	......	78.3
Fine corn meal	94	1	89.2	90.2	......	63.2	......	88.6	......	88.0
Cottonseed meal, high grade	92	2	*94.0	*99.1	26.7	82.1	......	93.1	100	......
Cottonseed meal, dark color	122	2	85.8	89.9	......	82.2	......	94.7	97.2	83.4
Cottonseed meal, medium grade	123	2	61.4	64.1	......	72.6	37.8	67.8	90.1	58.7
Cottonseed meal, low grade	124	2	73.0	78.0	......	83.6	......	43.5	82.1	71.8
Middlings	121	2	79.8	82.5	......	90.6	......	87.5	84.7	76.8
Corn meal and linseed, 1-1	106	2	89.2	91.2	42.6	87.5	80.4	95.1	85.9	......
Corn meal and linseed 1-1	120	2	83.7	86.6	......	85.3	79.3	89.9	78.7	81.3

* Probably too high.

SUMMARY OF DIGESTION COEFFICIENTS WITH STEERS.

Materials.	Number of experiment.	Number of animals.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Timothy hay (late cut)	95	2	54.9	55.5	41.5	35.3	54.8	59.4	35.7	51.6
Mixed hay, some clover....	111	2	58.3	59.5	37.9	35.3	59.6	63.0	46.8	55.0
Hay, largely timothy.......	127	2	55.7	57.4	25.6	40.7	57.0	60.0	38.3	51.9
Hay, mixed..................	114	2	58.8	60.2	35.4	47.8	54.7	66.1	45.4	56.9
Sanford corn fodder (few ears glazed)	107	2	72.9	74.6	48.7	56.9	79.8	74.4	72.3	70.8
Sanford corn silage (few ears glazed)	108	2	74.9	76.4	47.4	53.7	77.3	78.8	77.0	74.0
Leaming corn silage (immature corn)	109	2	63.1	64.4	31.7	46.7	67.2	65.1	68.3	62.4
Soy-bean and corn silage...	125	1	70.5	72.2	31.3	56.4	61.7	77.54	90.00	67.7
Soy-bean and corn silage fed with hay...............	126	2	70.3	71.1	45.8	57.7	55.1	80.00	88.00	71.7
Spring wheat bran..........	96	2	66.4	70.7	20.4	73.7	25.9	76.8	78.1	63.5
Winter wheat mixed feed..	97	2	70.76	73.0	34.3	76.7	50.3	76.5	......	70.0
Coarse corn meal	100	2	83.6	86.4	......	45.1	......	90.3	......	80.0
Fine corn meal..............	101	2	86.7	88.5	......	50.6	......	91.3	......	90.0
Feed flour	110	2	67.1	70.3	......	79.95	......	73.3	......	73.9
Middlings	129	2	83.4	88.3	......	72.7	......	98.6	......	82.9
Cottonseed meal (in ration hay 8, meal 1).............	98	2	77.8	87.8	84.3	76.1	55.1	93.1		
Cottonseed meal (in ration hay 8, cottonseed meal 2)	99	2	76.1	80.8	......	81.6	26.3	84.8		
Linseed meal................	112	2	84.1	87.2	36.8	85.7	69.6	91.4	......	88.4
Corn and linseed meal, 1-1.	113	2	91.5	92.5	52.8	86.2	93.0	96.8	81.3	
Corn and linseed meal, 1-1.	128	2	88.9	90.1	......	85.3	77.4	88.2	......	77.7
Gluten feed..................	116	2	87.6	90.6	......	86.6	......	85.4	80.2	86.3

AVERAGE OF THE DIGESTION COEFFICIENTS OBTAINED WITH SHEEP AND STEERS.

	Number of the Experiment.		Dry Matter.		Organic Matter.		Ash.		Protein.		Fiber.		Nitrogen-free Extract.		Ether Extract.		Fuel Value.	
	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.
			%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Timothy hay (late cut)	95	88	54.9	48.1	55.5	49.1	41.5	30.7	35.3	33.3	54.8	44.8	59.4	55.8	35.7	27.3	51.6	46.0
Spring wheat bran	96	89	66.4	69.5	70.7	72.8	20.4	31.5	73.7	76.3	25.9	66.7	76.8	73.0	78.1	40.5	63.5	64.0
Winter wheat mixed feed	97	90	70.7	72.5	73.0	77.6	34.3	39.5	76.7	78.0	50.3	72.3	76.5	......	......	......	70.0	71.8
Hay 8 parts, cottonseed meal 1 part.	98	91	57.5	54.3	59.2	55.7	71.1	29.3	56.5	59.5	56.6	49.7	61.2	58.1	69.8	56.1	54.7	51.5
Hay 8 parts, cottonseed meal 2 parts	99	92	59.6	58.7	61.0	59.5	35.5	29.1	68.0	68.5	53.1	50.1	62.1	61.1	68.4	62.2	56.6	53.1
Coarse corn meal	100	93	83.6	83.5	86.4	84.6	......	......	45.1	46.0	......	......	90.3	80.3	......	......	80.0	78.3
Fine corn meal	101	94	86.7	89.2	88.5	90.2	......	......	50.6	63.2	......	......	91.3	88.6	......	......	90.0	88.0
Corn fodder (Sanford corn)	107	102	72.9	64.9	74.6	67.0	48.7	18.6	56.9	46.7	79.8	69.9	74.4	68.2	72.3	59.3	70.8	......
Leaming corn silage	109	103	63.1	60.0	64.4	61.9	31.7	33.3	46.7	50.9	67.2	57.8	64.1	65.0	68.3	75.5	62.4	44.6
Mixed hay (timothy, red top, clover)	111	104	58.3	59.4	59.5	60.5	37.9	40.8	35.3	44.6	59.6	57.5	63.0	64.0	46.8	56.5	55.0	56.4
Linseed meal	112	*	84.1	81.2	87.2	84.5	36.8	69.6	85.7	87.2	69.6	......	91.4	85.5	......	91.9	81.3	88.4
Corn meal and linseed, equal parts	113	106	91.5	89.2	92.5	91.2	52.8	42.6	86.2	87.5	93.0	80.4	96.8	95.1	81.3	85.9	......	......
Soy-bean and corn silage	125	118	70.5	71.4	72.2	73.2	31.3	42.7	56.4	62.6	61.7	65.1	77.5	76.8	90.0	90.3	67.7	69.2
Hay largely timothy	127	119	55.7	49.3	57.4	51.2	25.6	6.2	40.7	36.5	57.0	45.9	60.0	57.7	38.3	57.1	52.0	48.5
Hay, linseed and corn meals	128	120	66.6	61.6	68.3	63.9	31.6	23.5	68.4	64.5	50.1	45.5	72.1	69.7	73.1	68.2	61.3	61.8
Linseed and corn meal, equal parts.	128	120	88.9	83.7	90.1	86.6	......	......	85.3	85.7	77.4	79.3	88.2	89.9	......	78.7	77.7	81.3
Gluten feed	116	*	87.6	86.3	90.6	87.3	......	......	86.6	85.6	......	......	85.4	89.2	80.2	84.4	......	......

* Bul. No. 77, U. S. Dpt. Agrlt.

COEFFICENTS OBTAINED WITH STEERS ALONE.

	Number of experiment.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
		%	%	%	%	%	%	%
Hay alone, 16 lbs. ration............	114	58.8	60.2	35.4	47.8	54.7	66.1	45.4
Hay 10 lbs., corn meal 6 lbs	115	68.9	70.4	36.5	51.9	65.8	78.4	61.0
Hay 10 lbs., gluten feed 6 lbs........	116	70.9	72.5	38.6	74.0	68.0	74.2	63.7
Corn meal	115	84.3	85.4	......	56.4	......	90.4	76.8
Gluten feed (10 hay to 6 gluten).....	116	87.6	90.6	......	86.6	......	85.4	80.2
Gluten feed (10 hay, 3 gluten)	117	90.0	93.4	......	86.0	......	89.5	......

DESCRIPTION OF EXPERIMENTS.

Experiment No. 86.—Clover silage. In the Station report for 1900, page 141, are given the results of a digestion experiment on clover silage. The results there given, especially on protein, were so much lower than those obtained from clover hay that it was thought desirable to repeat them. The results here given on page 196 are even lower than the others obtained, showing that the digestibility of clover is materially decreased by ensiling. The clover was chopped and well packed in the silo and came out in as good condition as any leguminous plant usually does.

Experiment No. 87.—Clover hay. The material used in this experiment was the same as was made into silage. It will be observed that the dry matter of this hay is 13 per cent and the protein over 21 per cent more digestible than in the silage.

Experiments No. 88-95.—Timothy hay. The hay used in this experiment was late cut and rather poor quality, as shown by the analyses and digestibility. It was prepared by chopping to about 2-inch lengths several hundred pounds, enough to last through the experiments with grain rations for the season, and thoroughly mixing to make it uniform. The hay was not very palatable and only small rations could be fed without some being left in the feed boxes. The coefficients obtained with the sheep are somewhat lower than those from the steers and are, probably, too low for the hay when fed with grain.

Experiments No. 89-96.—Spring wheat bran. This material was the ordinary coarse bran from spring wheat. The results show quite close agreement between the two different kinds of animals. The sheep however give coefficients averaging a little higher than the steers.

Experiments No. 90-97.—Winter wheat mixed feed. Winter wheat bran containing some middlings and often called mixed feed. This material gave little higher coefficients than the spring bran. The difference between the results of the different animals was about the same as for the spring bran, the sheep giving slightly higher results.

Experiments No. 91-98.—Mixed ration. Hay and cottonseed meal. A ration containing 8 parts hay to 1 of cottonseed meal was fed and the coefficients obtained for the mixture are given. The steers in this gave slightly higher results, except on protein. The cottonseed meal used was of the highest grade, carrying over 46 per cent protein.

Experiments No. 92-99.—Mixed ration. Hay and cottonseed meal. In these experiments the cottonseed meal was doubled and 8 parts hay to 2 parts cottonseed meal were used. The results obtained for the different animals agree very closely. Increasing the grain ration appeared to be favorable to the sheep.

Experiments No. 93-94-100-101 were made to compare the digestibility of coarse corn meal with that of finely ground. Both lots of animals gave higher coefficients for the fine meal than for the coarse, with quite close agreement, except on protein; and the low protein content of the ration probably accounts for that variation.

Experiments No. 102-107.—Corn fodder. The cut corn fodder used in these experiments contained very few ears that were glazed, most of them being immature when harvested. It was well cured and in good condition when fed. The steers ate their rations well, but the sheep did not appear to relish it and left a part of each ration. The coefficients obtained are considerably higher for the steers than the sheep, indicating that palatability may affect digestibility.

Experiment No. 108.—Sanford corn silage. This silage was made from the same material as the corn fodder. The coefficients obtained are slightly higher than those for the fodder cured by drying, except for the protein, which is lower. Only the steers were used in this experiment.

Experiments No. 103-109.—Leaming corn silage. The corn from which this silage was made was not as mature as the Sanford corn. This material was in good condition and well relished by both kinds of animals. The results are a little higher for the steers, except on protein.

Experiment No. 110.—Feed flour. In this experiment feed flour was fed with silage to determine the digestibility of the flour. The results with the sheep were unsatisfactory, so only those of steers are given.

Experiments No. 104-111.—Mixed hay. This hay was a mixture of timothy, red top, and clover. Enough for the purpose was chopped and mixed in the usual manner. The coefficients agree very closely, except in protein which is low in case of the steers.

Experiment No. 112.—Linseed meal. This experiment was made to compare the digestibility of linseed meal. The results obtained for the sheep were unsatisfactory, and those given were taken from Jordan's compilation, Bul. 77, Office Expt. Stations, U. S. Dept. of Agr., which agree well with those obtained for the steers.

Experiments No. 106-113.—Linseed meal and corn meal. This experiment was made with linseed and corn meal, equal parts mixed. The coefficients of both steers and sheep are quite high, but agree very closely. The protein of the mixture is as digestible as that of the linseed alone.

Experiment No. 114.—Hay (mixed). The digestibility of this hay was determined for use in subsequent feeding experiments with grain. The sheep secured proved unsatisfactory, as before stated, and only the steers were used.

Experiment No. 115.—Hay and corn meal. Ten pounds of hay were fed with six pounds of corn meal.

Experiment No. 116.—Hay and gluten feed. Ten pounds of hay were fed with six pounds of gluten feed.

Experiment No. 117.—Gluten feed. Ten pounds of hay were fed with three pounds of gluten feed.

Experiments No. 118-125.—Soy bean—corn silage. This material was grown on the farm and was put in the silo in the proportion of nine parts of beans to fourteen of corn. The coefficients for the different kinds of animals agree very closely. The material was well relished.

Experiment No. 126.—Soy bean—corn silage. In this trial only the steers were used and the silage was fed with some hay. It will be noticed that the results are practically the same for the silage as when it was fed alone.

Experiments No. 119-127.—Hay. This hay was largely timothy of fair quality. The steers in this experiment as in Nos. 88-95 gave higher digestion coefficients than the sheep, although this was a different lot of sheep.

Experiments No. 120-128.—Linseed and corn meal. A mixture of hay, linseed and corn meal was fed. The steers as before gave slightly higher results, but the coefficients agree quite well with the ones obtained in Experiment No. 113, particularly the protein.

Experiments No. 121-129.—Middlings. In these experiments, through a mistake, two different lots of middlings were used, therefore the results cannot be compared.

Experiments No. 122-123-124.—Cottonseed meals. These meals are of different grades and the experiments were made with sheep. These meals will be made a subject for discussion in a later bulletin, consequently the coefficients obtained are presented here without comment.

DISCUSSION OF RESULTS.

In studying the table giving the coefficients obtained from the steers and sheep, it will be noticed that there are differences which are somewhat remarkable and should have some explanation. In experiments No. 88-95 with hay alone, the steers gave a coefficient over 6 per cent higher for the dry matter than the sheep, but in the next two experiments when bran was fed with the hay, the sheep gave higher coefficients for bran than the steers. Also in experiments No. 91-98, when one part cottonseed meal to eight parts hay is fed, the steers show only 3 per cent greater digestibility for the dry matter of the ration; and in the following experiment, where two parts cottonseed meal to eight of hay are fed, the steers digest only 1 per cent more of the dry matter from the mixture. Calculating the digestibility of the cottonseed meal for the sheep, using the coefficients obtained in experiment No. 88 for the hay, gives a coefficient for the dry matter of nearly 100 per cent when one part of cottonseed meal is fed, and when two parts are fed about 94 per

cent for the dry matter. This seems to indicate one of two things, that the coefficients for the sheep on the hay are too low, or the addition of the grain to the ration materially increased their capacity to digest the hay. It is quite probable that this latter explanation is the correct one, as other experiments show they have no greater capacity to digest cottonseed meal than the steers. The experiment with the hay was carefully made, the results of the two sheep agree closely and there is no reason to distrust the figures. The hay was rather poor quality, very low in protein and not as well relished by the sheep as the steers. In experiment No. 119 the sheep gave coefficients for dry matter only about 1 per cent higher on a somewhat better timothy hay and were still 6 per cent below the steers.

In the experiment with corn fodder (which the sheep did not relish) the steers gave coefficients nearly 10 per cent higher on the dry matter than the sheep; but in the experiment with corn silage, which was well relished by both lots of animals, the coefficients agree more closely.

In the third season, when the experiments were made only with the steers, there are some results obtained on the digestibility of gluten feed and corn meal which are of special interest. (See table on page 199.) In experiment No. 115 a ration of 10 pounds of hay to 6 pounds of corn meal was fed. And in experiment No. 116 10 pounds of hay to 6 pounds of gluten feed was given. In the mixture with corn meal 68.9 per cent of the dry matter was digested and only 51.9 per cent of the protein, but in the ration where the corn meal was replaced by the gluten feed, 70.9 percent of the dry matter was digested and 74.5 per cent of the protein—a difference of 2 per cent of the dry matter and over 22 per cent for the protein. Calculating the digestibility of the corn meal and gluten alone, the dry matter of the corn meal is 84.3, the gluten 87.6, while the protein of the corn meal is 56.4 per cent and the gluten feed 86.6 per cent—a difference in dry matter of about 3 per cent and protein about 30 per cent. When the protein of these two rations is from the same source, corn, it seems very improbable that such a difference in digestibility exists, and the very low figures obtained for the corn meal are due to metabolic products in the feces, which offset the coefficient much more when a ration very low in protein is fed, than when

it is well balanced. It is probable that the protein of the corn meal is really as digestible as that of gluten feed, and this assumption seems to be supported by experiments No. 106-113-120-128 where corn and linseed meals are fed in equal parts, and the coefficients for the protein of the mixed grains are 86.2 and 85.3. This higher coefficient cannot be attributed to the greater digestibility of the linseed, for experiment No. 112 on linseed alone gave a coefficient of only 85.7 for the protein. A more nitrogenous or better balanced ration may in part account for the greater digestibility of the dry matter and protein.

CONCLUSIONS.

Of the animals used in these experiments the steers had a greater capacity for digesting coarse fodders low in protein, like timothy hay and corn fodders, than the sheep.

The more nitrogenous rations were as well and in some cases better digested by the sheep than by the steers, and the addition of nitrogenous grains to the ration appeared to materially increase the sheep's digestive capacity.

The feeding of grain rich in protein with corn meal apparently increased the digestibility of the ration, particularly that of the protein.

It is evident from a study of these results and others before published that as great differences in digestion coefficients will occur between sheep, individually, as is likely to occur between sheep and steers. But if sheep are to be used to determine coefficients for bovines, great care should be taken to select strong animals that are good feeders and will eat coarse fodders readily, otherwise results which are too low are likely to be obtained.

THE INCOME AND OUTGO OF NITROGEN.

J. M. Bartlett.

In conducting digestion experiments in which the urine can be collected, it is customary to make a comparison between the amount of nitrogen taken into the body and that excreted during the same period. This comparison of the income and outgo constitutes what is known as the nitrogen balance. It is made for the purpose of ascertaining if the loss of nitrogen in the urine and feces is made good by the food. Too much is not claimed for the results thus obtained, since it is known that a part, at least, of the nitrogen taken in is delayed in its passage through the body. This nitrogen lag makes it impossible to tell if the nitrogen excreted during any period exactly corresponds with the income at any preceding period. Nevertheless, if the experiment be continued for a considerable length of time, an equilibrium must at length be established. If the body is not gaining weight, the outgo should now exactly counterbalance the income. On the other hand, an excess of income nitrogen indicates a gain, and a deficiency a loss in body weight. In the experiments described in the preceding pages the feces and urine were collected only after a preliminary feeding period of seven days, when it would seem that the equilibrium must have been established.

The whole amount excreted by the sheep for the five days was weighed, thoroughly mixed, and a sample drawn for analysis. Each day's excretion from the steers was weighed and an aliquot portion taken for a composite sample. The samples were preserved with formaldehyde. The following tables give the data obtained on the urines in these experiments.

NITROGEN IN THE URINE—SHEEP.

Number of experiment.	Animal's number.	Weight of urine.	Per cent of nitrogen in urine.	Weight of nitrogen.	Heat of Combustion.	
					Per gram.	Total.
		Grams.		Grams.	Calories.	Calories.
89	I	3172.0	1.77	56.14	-	-
89	II	2432.0	2.08	50.59	-	-
89	III	2540.0	2.08	52.00	-	-
91	I	1962.0	1.76	34.53	-	-
91	II	1945.0	1.93	37.54	-	-
92	I	3106.0	2.61	81.07	311	966
92	II	3501.0	2.35	82.27	257	900
93	I	2214.0	0.62	15.66	225	497
93	II	2238.0	0.70	15.67	200	448
94	I	1795.0	0.87	15.62	295	529
94	II	1732.0	0.87	15.07	278	481
105	I	2860.0	2.80	80.28	376	1075

NITROGEN IN THE URINE—STEERS.

Number of experiment.	Animal's number.	Weight of urine.	Per cent of nitrogen.	Weight of nitrogen.	Heat of Combustion.	
					Per gram.	Total.
		Grams.		Grams.	Calories.	Calories.
95	I	16960	0.59	100.1	.281	4770
95	II	17370	0.59	102.5	.281	4881
96	I	15780	0.97	153.1	.204	3220
96	II	17830	0.86	153.3	.213	3797
97	I	11110	1.16	128.9	.303	3367
97	II	16920	0.75	126.9	.179	3029
98	I	15330	1.37	214.6	.266	4078
99	I	13970	1.87	261.3	.407	5975
99	II	16650	1.48	246.4	.374	6326
100	I	20320	0.35	711.3	.192	3946
100	II	16100	0.45	725.0	.214	3446
101	I	15330	0.45	690.0	.183	2806
101	II	15060	0.46	692.7	.190	2861
107	I	11020	1.11	122.3	.249	2743
107	II	12020	1.14	137.0	.256	3077
108	I	25850	0.20	517.2	.086	2223
109	I	22910	0.25	573.0	.111	2543
109	II	30250	0.24	727.7	.107	3237
110	I	15740	1.20	188.9	.278	4476
110	II	24670	0.92	227.0	.192	4736
112	I	15420	1.36	209.2	.246	3793
113	I	13020	1.43	181.6	.320	4166
113	II	12880	1.47	189.4	.332	4277
114	I	21550	0.91	196.1	.242	5215
114	II	21320	0.96	204.7	.264	5630
115	I	21090	0.94	198.3	.255	5380
115	II	18870	1.05	198.1	.299	5640
116	I	24400	2.12	517.3	.352	8588
116	II	23590	2.25	530.8	.355	8376
117	I	20180	1.74	351.1	.296	6270
117	II	21950	1.78	391.0	.277	6078

BALANCE OF INCOME AND OUTGO OF NITROGEN FOR EACH EXPERIMENT—STEERS.

Number of experiment.	Animal's number.	Income nitrogen in food.	Outgo.			Nitrogen, gain + loss —	Protein, gain + loss —
			Nitrogen in feces.	Nitrogen in urine.	Nitrogen total.		
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
95	I	141.5	95.9	100.1	196.0	—54.5	—340.7
95	II	141.5	89.2	102.5	191.7	—50.1	—313.5
96	I	309.3	129.1	153.1	282.2	+27.1	+169.2
96	II	309.3	128.1	153.3	281.4	+27.9	+174.6
97	I	299.4	119.7	128.9	248.6	+50.8	+320.2
97	II	299.4	122.2	126.9	249.1	+50.3	+314.2
98	I	327.5	143.5	214.6	358.1	—30.6	—189.3
99	I	480.8	153.0	261.3	414.3	+66.5	+415.7
99	II	480.8	155.3	246.4	401.7	+79.1	+494.4
100	I	247.2	153.2	71.1	224.3	+22.9	+142.9
100	II	210.9	148.4	72.5	220.9	—10.0	—62.5
101	I	245.4	150.6	69.0	219.6	+15.8	+98.8
101	II	209.1	123.0	69.3	192.3	+16.8	+105.2
107	I	215.9	91.6	122.3	214.0	+1.9	+12.2
107	II	215.9	93.4	137.0	230.4	+14.5	+90.7
108	I	205.0	94.4	51.7	146.1	+58.9	+368.3
109	I	174.2	91.2	57.3	148.5	+25.7	+160.8
109	II	174.2	94.6	72.6	167.2	+7.0	+43.9
110	I	484.4	137.7	188.9	326.6	+157.8	+986.6
110	II	484.4	127.2	227.0	354.2	+130.2	+813.8
112	I	489.0	175.3	209.7	385.0	+104.0	+649.2
113	I	565.7	171.1	181.6	352.7	+213.0	+1331.0
113	II	565.7	173.5	189.4	362.9	+202.8	+1268.0
114	I	342.0	178.5	196.1	374.6	—32.6	—203.8
114	II	342.0	181.7	204.7	386.4	—44.4	—277.5
115	I	434.1	211.8	198.2	410.0	+24.1	+150.5
115	II	434.1	211.4	198.1	409.5	+24.6	+153.8
116	I	834.2	216.0	517.6	733.6	+100.6	+628.7
116	II	834.2	210.0	530.8	740.8	+93.4	+586.6
117	I	567.5	184.5	351.1	535.6	+33.9	+227.4
117	II	567.5	183.1	391.0	574.1	—6.6	—41.4

BALANCE OF INCOME AND OUTGO OF NITROGEN FOR EACH EXPERIMENT, SHEEP.

Number of experiment.	Animal's number.	Income nitrogen in food.	Outgo.			Nitrogen, gain+ loss—	Protein, gain+ loss—
			Nitrogen in feces.	Nitrogen in urine.	Nitrogen total.		
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
89	I	63.3	25.20	56.14	81.34	—18.04	—112.7
89	II	63.3	26.14	50.59	76.73	—13.43	—83.96
89	III	63.3	24.38	52.00	76.38	—13.08	—81.78
91	I	68.6	32.16	34.53	66.69	+1.91	+11.97
91	II	68.6	27.80	37.54	65.34	+3.26	+20.32
92	I	106.0	30.76	81.07	111.83	—5.83	—36.43
92	II	106.0	33.10	82.27	115.37	—9.87	—58.58
93	I	38.5	23.74	13.66	37.40	+1.10	+6.88
93	II	38.5	23.22	15.67	38.89	—0.39	—2.44
94	I	38.0	19.94	15.62	35.56	+2.44	+15.25
94	II	38.0	21.19	15.07	36.26	+1.74	+10.88
105	I	127.7	26.14	80.28	106.42	+21.28	+13.30

NEWSPAPER BULLETINS PUBLISHED IN 1904.

CHAS. D. WOODS.

Whenever there is a matter of importance which we wish to bring promptly to the attention of the people of the State, we make as clear and concise a statement as possible in the style and type of a newspaper column and mail it as a "Special Newspaper Bulletin" to all the press on the Station exchange mailing list. These newspaper bulletins are quite generally printed by the papers, and the Station is under obligations to the press for this opportunity of specially and promptly being put in touch with the people.

During the year the Station has issued several special newspaper bulletins on miscellaneous subjects. The subject matter of five of the newspaper bulletins has not appeared in any of the regular bulletins of the Station and are therefore here reprinted as a matter of permanent record.

RE-TOPPING SWEET APPLE TREES.

A correspondent recently sent to the Maine Agricultural Experiment Station the following questions which were answered by Professor W. M. Munson as below:

"Can sweet apple trees be successfully grafted? Will it pay to re-top a large sweet apple tree, a foot or more in diameter? Should an orchard of 100 trees be all of one variety?"

It is very doubtful if the flavor of the fruit has any relation to the value of a given tree for purposes of grafting. Tolman Sweet is often used as a basis for top-working.

Apple trees up to a foot in diameter may be top-worked if unsatisfactory. Care, however, should be used that too much

of the top is not removed in any one year. Cut off about one-third of the top the first year and insert cions on stubs not more than two or three inches in diameter. The next year remove more of the top and insert other cions, and the following year complete the work.

It is not advisable to plant a solid block of 100 trees of one variety unless there are other trees in the immediate vicinity. Some varieties are self-fertile and will give satisfactory results if planted alone; but it is always safer to provide for cross fertilization. In large orchards every third or fourth row should be of a different variety. Two or three varieties are enough for a commercial orchard, however, and it is seldom advisable to plant more.

MULCHING FOR APPLES TREES AND GOOSEBERRIES.

A correspondent recently sent to the Maine Agricultural Experiment Station the following questions which were answered by Professor W. M. Munson, as below:

"Is the waste from shingle mills ("shingle hair") a better mulch for apple trees than sawdust? Is there any objection to pine needles as a mulch for gooseberry bushes?"

Shingle edgings ("shingle hair") are excellent for mulching either apple trees or strawberry plants. As in the case of sawdust, it is better to use material that is not quite fresh; or take precautions so as to keep it from packing closely about the base of the tree. Sawdust is the most satisfactory material ever used at the Station as a winter protection and summer mulch for strawberries. It conserves the moisture effectively and is free from weeds.

The best mulch for gooseberries, as for other small fruits, is a fine dust cover provided by thorough cultivation. If for any reason this can not be given, I see no objection to the use of pine needles or the "shingle hair," referred to above.

TESTING VITALITY OF SEEDS.

Owing to the unfavorable season of 1903, many kinds of seeds failed to mature properly and it is probable that there will be many disappointed growers during the present season. Prof. W. M. Munson makes the following suggestions, whereby it is possible for every farmer to know just what to expect from his corn, oats, peas, clover or other crops, and to plan accordingly. If he knows that only 50 per cent of his corn will germinate, it is an easy matter to plant twice as much; but if he plants the usual amount and gets only half a stand, the case is much more serious.

A simple test of the vitality of any farm or garden seeds can be made as follows: Place 100 seeds, taken at random from the stock which is to be planted, on a dish of sand, cover from ½ to 1 inch with sand, moisten and keep in a warm place, as behind the kitchen stove, until the sprouts appear. The number of sprouts which appear will give an idea of the percentage which may be expected to grow. Care should be taken that the seeds are kept moist, but not too wet. It is advisable to make more than one test, and be guided by the average results. A test of this kind is more valuable than one in which the seeds are placed in blotting paper, for seeds may sprout on paper which do not have sufficient vitality to grow.

OAT SMUT AND ITS PREVENTION.

Oat smut is much more prevalent in Maine than is commonly supposed and while the loss is not total in any field, observations and reports from correspondents indicate that the loss as a whole is large. The disease is propagated by means of the seed, and all that is necessary to prevent smut is to kill the spores that are upon the oats used for seed. This can be accomplished in a number of ways. By treating the seed with water hot enough to kill the smut spores and yet not injure the seed, many growers in the State have materially reduced the smut in their fields. The treatment with formaldehyde is the better one as it is sure, safe, and easy.

The Maine Agricultural Experiment Station has issued a 4-page pamphlet on the prevention of oat smut from which the following is condensed: Half fill an oil or similar barrel with water, and add one-half pound of formaldehyde (sometimes called formalin). Place about two bushels of the seed oats in as wide a sack as will readily go into the barrel, and submerge the oats in this weak solution of formaldehyde for 20 minutes. Lift the sack from the barrel, allow it to drain a few minutes so as not to waste the solution. Then empty the oats on to a clean floor or canvas to dry, and proceed in the same manner until all the seed has been treated.

A solution of formaldehyde the strength recommended above is not poisonous and will not injure the barrel, the sack or clothing coming incontact with it, nor will it interfere with the germination of the oats. On the contrary, the treatment of the seed seems to facilitate the sprouting, hastening it by 2 or 3 days. The seed should be treated long enough beforehand to give it time to dry out before using.

MAKING CLOVER HAY. THE METHOD FOLLOWED AT THE MAINE AGRICULTURAL EXPERIMENT STATION.

The Station has received quite a number of inquiries relative to the method here used in curing clover and similar succulent crops. Prof. G. M. Gowell has outlined our method as follows:

The practice at the Maine Agricultural Experiment Station in curing clover, is to mow it when there is a prospect of dry weather for a couple of days and when it is free from water or dew, and let it lie as cut that day, or, if it has wilted somewhat on the surface turn it by hand or tedder just before night. If not turned the first afternoon it is turned or teddered early the second day and again towards noon.

In the afternoon of the second day it is put into cocks about 5 feet high. Ordinarily it is wilted at this time, but if the weather has turned dark, or the clover is very heavy, portions of it are liable to be unwilted, in which case the cocks are made similar. The cocks are made by using small fork fulls flattened out, so that it will come off in layers when handled again. As it cures it settles, and unless the cocks are high in proportion to their width they will flatten out, which is wrong. The walls are kept perpendicular three-fourths of the way up and then gradually drawn in. Much time need not be consumed in making the bunches, as it is quickly done.

One condition is imperative—the clover must go into the cock free from rain or dew. It can be safely cocked when containing lots of water from its own juices, but not when even a little moist from water.

We allow it to stand in cocks three or four days, or longer, before disturbing it. On a day in which the air is dry we open up the bunches so that the air can draw through them, and usually after about two hours' exposure the hay is ready to draw to the barn. It is not necessary to tear it apart and wear it out, as it readily parts with its own moisture, which is chiefly near the center and the bottom of the bunches.

If rain falls while the clover is in the bunch, it does not wet in deeply after the bunches have been made for a few hours. When rain comes we let the bunches alone, and the water dries out of itself when sound weather comes again.

To successfully cure clover or other fodder plants in this way it is essential to let the cocks alone, and allow them to cure and dry out undisturbed. Clover thus cured and aired out just before putting into the barn does not burn in the mow or come out dusty. In mid-winter a handful from the mow can be twisted into a knot without breaking the stalks or wringing off the leaves.

We also cure green oats and peas in the same way. Out of 32 tons weighed into the barn one year, and fed out in winter, all of the orts made from it by the cattle were collected and saved in one sack!

This method of curing succeeds in ordinary weather. Of course heavy prolonged rains mean defeat to this or any system unless the bunches are covered with cloth or fiber caps.

METEOROLOGICAL OBSERVATIONS.

Lat. 44° 54′ 2″ N. Lon. 68° 40′ 11″ W. Elevation 150 feet.

The instruments used at this Station are the same as those used in preceding years, and include: Wet and dry bulb thermometers; maximum and minimum thermometers; rain-gauge; self-recording anemometer, vane, and barometer. The observations at Orono now form an almost unbroken record of thirty-six years.

The past year was exceptionally cold. During the time that temperature observations have been made at Orono, but three years have exceeded 1904 in this respect. These years, with their mean temperatures, were: 1873, 40°.48; 1875, 39.°20; 1893, 40°.57. That of 1904 was 40.°67, and the mean for 36 years was 42.°15.

The mean temperature for February and December was the lowest thus far recorded here for these months; February being nearly 7°.0, and December 8.°5 below the average. January was 5°.5 and November nearly 4°.0 below the mean.

The total precipitation for the year was a trifle more than that for the preceding year, but was still 6 inches below the average. The fall for November was especially small, not only at Orono, but at most of the stations recorded in the table on page 217.

METEOROLOGICAL SUMMARY FOR 1904.

Observations Made at the Maine Experiment Station.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest barometer	30.62	30.47	30.78	30.29	30.16	30.33	30.04	30.25	30.34	30.83	30.50	30.44	30.42	......
Lowest barometer	29.13	29.06	29.32	29.27	29.16	29.44	29.54	29.64	29.10	28.99	29.18	28.83	29.22	......
Mean barometer	29.85	29.87	29.90	29.78	29.81	29.90	29.84	29.90	29.93	29.94	29.76	29.80	29.86	......
Highest temperature	41°.0	43°.0	51°.0	62°.0	82°.0	87°.0	87°.0	88°.0	80°.0	69°.0	50°.0	39°.0	....	......
Lowest temperature	−26°.0	−26°.0	−7°.0	16°.0	29°.0	38°.0	46°.0	40°.0	26°.0	20°.0	0°.0	−27°.0	....	......
Mean temperature	10°.3	12°.2	28°.9	41°.0	58°.1	60°.8	68°.8	64°.2	55°.5	46°.0	30°.4	11°.8	40°.67	......
Mean temperature for 36 years	15°.86	19°.02	28°.11	40°.67	52°.50	61°.25	66°.88	64°.92	57°.26	44°.80	34°.13	20°.34	42°.15	......
Total precipitation in inches	3.63	2.57	3.18	3.13	4.26	2.17	2.43	4.46	6.47	3.10	1.62	2.00	....	39.02
Mean precipitation for 36 years	4.29	3.94	4.45	2.84	3.48	3.53	3.33	3.60	3.41	3.91	3.71	3.77	....	44.26
No. of days with precip. of .01 in. or more	8	11	9	10	11	8	10	10	13	10	7	7	....	114
Snow fall in inches	34.0	18.0	12.0	3.5	....	....	....	....	....	Trace.	5.7	19.2	....	92.4
Average snow fall for 36 years	23.0	21.4	16.2	5.2	0.3	....	....	....	....	0.9	8.2	17.0	....	92.2
Number of clear days	11	9	10	9	12	14	14	18	13	13	11	19	....	153
Number of fair days	5	6	6	5	10	5	10	6	2	6	6	3	....	70
Number of cloudy days	15	14	15	16	9	11	7	7	15	12	13	9	....	143
Total movement of wind in miles	4407	5567	6798	5756	6335	4280	5157	4858	5094	6298	4594	3319	....	......

Monthly and Annual Precipitation (as rain) for the Year 1904.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Bar Harbor	5.37	4.05	5.37	5.02	4.62	1.40	1.72	5.24	9.81	2.55	2.25	4.63	52.03
Belfast	4.86	1.84	3.14	5.06	6.51	1.03	1.23	4.66	6.30	2.91	......	......	......
Cornish	3.39	2.14	3.95	7.67	5.71	2.94	2.24	5.12	5.10	1.41	1.24	1.66	42.57
Eastport	3.04	3.97	4.95	3.36	2.23	1.29	2.10	6.10	5.36	2.54	1.54	2.41	38.89
Fairfield	3.21	1.65	3.78	5.75	4.75	2.32	2.69	4.39	5.58	2.05	1.61	1.44	39.22
Farmington	3.52	0.72	3.13	6.30	5.72	1.03	4.97	4.58	4.44	2.09	1.83	1.76	40.09
Fort Fairfield	......	0.80	0.95	1.35	2.10	......	......	......	......	......	......	1.31	......
Gardiner	4.12	2.24	3.71	7.10	3.95	1.29	1.25	4.53	5.09	2.02	2.39	2.28	39.97
Houlton	4.60	2.35	2.60	2.80	3.65	2.52	2.58	3.00	6.70	3.40	2.20	1.44	37.84
Lewiston	4.26	2.32	3.71	6.74	4.34	2.64	2.39	4.29	3.82	1.88	2.63	1.93	40.95
Mayfield	3.07	1.81	2.76	3.42	6.86	3.17	4.41	5.32	5.73	2.42	1.58	1.47	42.02
Millinocket	3.35	1.89	3.86	2.82	4.38	2.16	4.96	4.06	6.46	3.21	2.20	1.89	41.24
North Bridgton	4.58	2.46	3.47	5.90	4.31	2.87	2.96	5.91	4.25	1.70	1.33	1.67	41.41
Oquossoc	2.86	1.08	2.00	4.56	3.23	2.98	2.89	4.77	6.63	1.69	1.39	1.99	36.07
Orono	3.63	2.57	3.18	3.13	4.26	2.17	2.43	4.46	6.47	3.10	1.62	2.00	39.02
Patten	2.90	0.60	1.02	2.90	4.25	4.15	4.30	2.49	10.42	3.10	1.82	1.50	39.45
Portland	4.04	2.35	2.52	7.51	4.75	2.45	1.03	3.64	3.49	1.16	1.93	1.43	36.30
Rumford Falls	2.88	1.41	2.51	5.72	3.89	2.42	2.34	4.10	4.75	2.76	1.43	1.51	35.72
South Lagrange	2.10	1.50	3.60	3.03	4.85	2.62	4.77	5.10	5.93	2.40	1.92	1.75	39.57
Thomaston	......	2.20	3.79	6.52	7.00	1.68	1.95	4.31	......	......	......	......	......
Van Buren	2.76	2.19	3.28	2.21	5.04	2.74	4.85	2.16	5.10	......	0.74	1.43	......
Vanceboro	3.33	1.10	......	2.83	2.92	......	......	2.14	6.76	2.66	1.45	0.98	......

With the exception of readings from the Orono station, the above table is compiled from the monthly bulletins of the U. S. Weather Bureau.

REPORT OF THE TREASURER.

Maine Agricultural Experiment Station in account with the United States appropriation, 1903-1904.

DR.

To receipts from the Treasurer of the United States as per appropriation for the fiscal year ending June 30, 1904, as per act of Congress approved March 2, 1887		$15,000 00

CR.

By salaries:		
(a) Director and administration officers	$2,500 00	
(b) Scientific staff	4,000 00	
(c) Assistants to scientific staff	1,345 80	
Total		$7,845 80
Labor:		
(a) Monthly employees	$1,410 05	
(b) Daily employees	683 52	
Total		2,093 57
Publications		241 26
Postage and stationery		226 68
Freight and express		217 16
Heat, light and water		443 07
Chemical supplies:		
(a) Chemicals	$195 60	
(b) Other supplies	163 84	
Total		359 44
Seeds, plants and sundry supplies:		
(a) Agricultural	$179 31	
(b) Horticultural	191 52	
(c) Botanical	85	
(d) Entomological	60 29	
(e) Miscellaneous	140 69	
Total		$572 66
Fertilizers		240 04
Feeding stuffs		685 26
Library		265 45
Tools, implements and machinery		291 89
Furniture and fixtures		186 52
Scientific apparatus		172 65
Live stock:		
(b) Cattle	$100 00	
(f) Sundries	17 30	
Total		117 30
Contingent expenses		28 50
Traveling expenses		262 75
Buildings and repairs		750 00
Total		$15,000 00

ISAIAH K. STETSON, *Treasurer.*

I, the undersigned, duly appointed Auditor of the Corporation, do hereby certify that I have examined the books of the Maine Agricultural Experiment Station for the fiscal year ending June 30, 1904, that I have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements, $15,000.00; for all of which proper vouchers are on file and have been examined by me and found correct.

And I further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

GEORGE E. FELLOWS, *Auditor.*

Maine Agricultural Experiment Station in account with "General Account" for the year ending June 30, 1904.

DR.

To balance from 1902-1903	$120 86	
Sales of produce, fees, etc	6,101 18	$6,222 04

CR.

By salaries	$2,813 08	
Labor	358 27	
Feeding stuffs	955 72	
Traveling expenses	451 23	
Buildings and repairs	1,589 67	
Balance to 1904-1905 account	54 07	$6,222 04

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